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PUNJAB CANAL GAZETTEERS.

Volume II.

THE TRIPLE CANALS

(UPPER JHELUM CANAL, UPPER CHENAB CANAL AND LOWER BARI DOAB CANAL).

HISTORICAL, PROFESSIONAL AND STATISTICAL.

COMPILED AND PUBLISHED UNDER THE AUTHORITY OF THE PUNJAB GOVERNMENT.

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PREFACE.

THE canal-irrigated area in the Punjab is now 9 million acres annually and will be over 10 millions when the Triple Canals Scheme is in full operation. With the completion of other canals now under consideration and with greater improvements in the management of the existing canals the area should reach 15 million acres against famine and scarcity.

Any one desirous of ascertaining how the canals are administered will find the required information in the Public Works Department Code, the Northern India Canal Act No. VIII of 1873, the Punjab Irrigation Manual of Orders, the Canal Revenue Manual, *Project Completion Reports*, Arboricultural Reports, Colony Reports, Annual Administration Reports and Blue Books of Statistics. Laymen desirous of acquiring some knowledge of the working of the large Punjab Canals usually have not the time to wade through all these codes and works of reference. In this gazetteer it is intended to describe the Triple Canal System in a popular, non-professional manner for the convenience of the non-professional reader.



This illustrates what Government waste lands will look like when irrigation is developed in a few years time. This illustration speaks volumes.

GAZETTEER

OF THE

TRIPLE CANAL SYSTEM, PUNJAB.

CHAPTER I.—History of the Project.

THE Triple Canal System comprises three separate canals, *viz.*, the Upper Jhelum, the Upper Chenab, and the Lower Bari Doab Canals. The interests of these canals are linked together by the fact that the surplus waters of the Jhelum, Chenab and Ravi Rivers are pooled for the benefit of the tracts respectively commanded by the three canals. The scheme in some measure affects the interests of three older canals which offtake from the same three rivers, *viz.*, the Lower Jhelum Canal, opened in 1901, the Lower Chenab, opened in 1892, and the Sidhnai, opened in 1887. On the general Irrigation Department Map (Plate 1) these canals are all marked in the Jhech, Rechna and Bari Doabs. The Upper Jhelum Canal is the most northern, the Upper Chenab is the middle link, and the Lower Bari Doab is the most southern of the Triple Canal System.

When the Lower Jhelum Canal was approaching completion, in 1901, Mr. S. Preston, Chief Engineer, Irrigation Works, Punjab, following some earlier proposals, prepared a project in full detail for using the combined flow of the River Sutlej and its tributary, the Beas, for the irrigation of the Lower Bari Doab from where the Upper Bari Doab Canal ceased to irrigate down to the confluence of the rivers Sutlej and Chenab. The surveys and estimates were complete, and it was estimated that the return on the proposed outlay would be 6.6 per centum, after covering working expenses. The project was well on its way to being sanctioned when an objection was raised against the utilization of the Beas and Sutlej waters in this manner. All down the Sutlej River both in British Territory and in the Bahawalpur State, the riverain population, who had vested interest in the Sutlej supply, objected to the abstraction of the water in which they were deeply concerned.

In October 1901 the Hon'ble Mr. J. Wilson, C.S.I., then Settlement Commissioner, Punjab, drew attention to the fact that it was contrary to past practice in the Punjab to irrigate in a

CHAP. I.

History of the Project.

and much other machinery and tramway plant. The two photographs of the Tramway Plant and of the Steam Navvies at work on the Mangla Cut, facing this page, are characteristic of the means of construction employed on this canal. The question of the best design of masonry works at the point of transit of hill torrents across the canal alignment, of which there were a great many, called for much anxious thought. Among other works requiring careful consideration was the question of diverting the Bhimber torrent into the river Chenab instead of passing it across the canal. While these matters were being investigated, channel excavation was in progress. Once these engineering problems had been decided the progress was rapid, and in 1911-12 the expenditure, direct and indirect, exceeded Rs. 70 lakhs. By December 1915 the canal was sufficiently advanced to allow of a supply being passed into it; and on the 9th of that month His Excellency the Viceroy presided at the ceremony of the formal opening of the canal for irrigation.

CONSTRUCTION, UPPER CHENAB CANAL.

Work was commenced in 1905. It was decided to complete the construction of the canal and open it for irrigation as quickly as possible. It was to be a canal of greater capacity than the existing canal which off took from the river Chenab at Khanki and which had been opened for irrigation in 1892. The headworks at Merala, and the main canal, were completed in 7 years. In the year 1908-09 the expenditure on construction exceeded 49 lakhs of rupees. On the 12th April 1908 His Excellency the Viceroy presided at the ceremony of the formal opening of the canal and started it on its career of usefulness. It began to bring in revenue almost immediately, and when the capital account was closed, on 31st March 1917, the account of the canal showed that during the preceding twelve months showed a revenue of over Rs. 25 lakhs, and a crop production to the value of over Rs. 150 lakhs.

CONSTRUCTION, LOWER BARI DOAB CANAL.

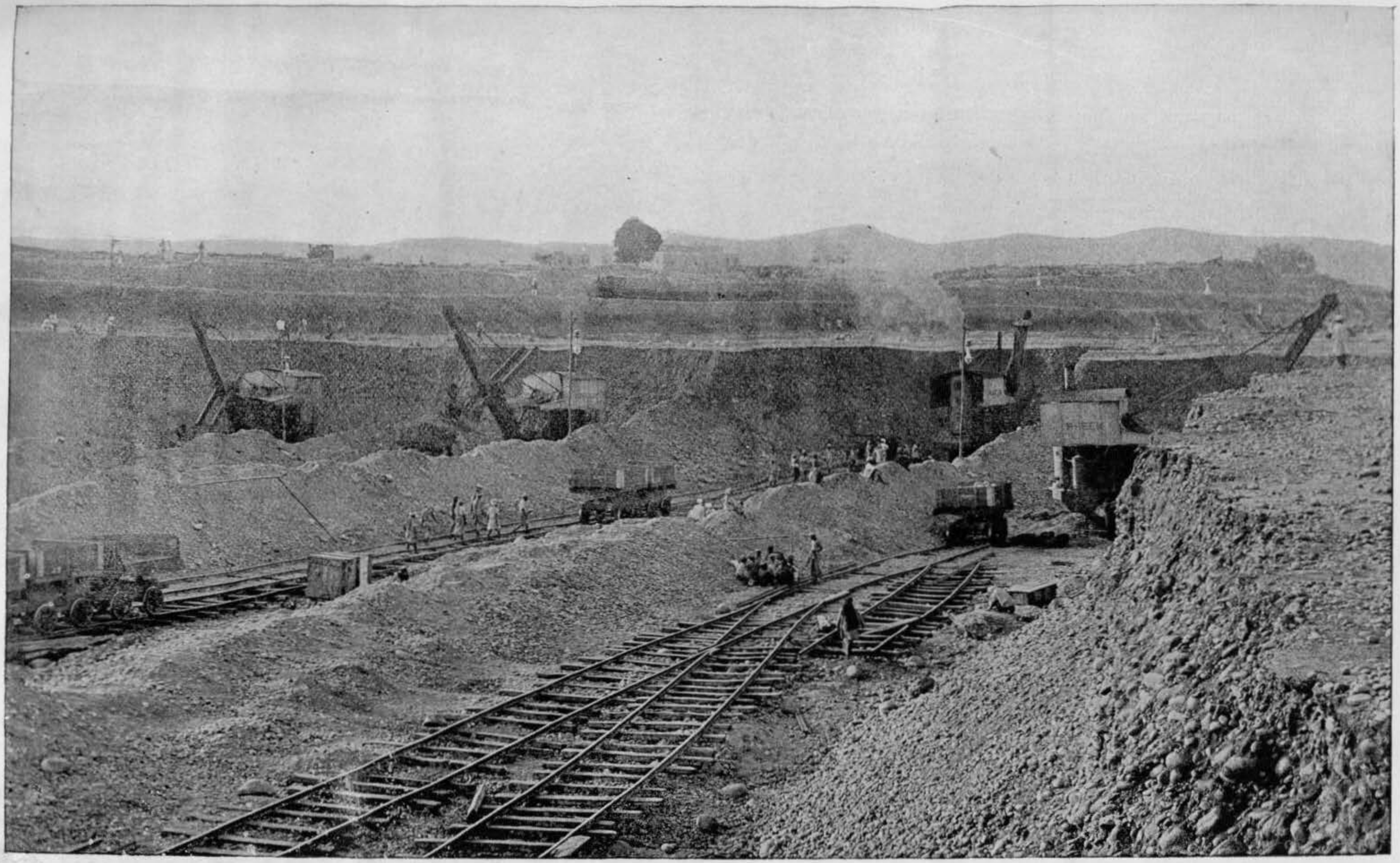
Work was commenced in 1906, but a great deal of time was spent in locating the Ravi crossing, and in finally deciding the nature of the work to be built there. The project provided for a syphon, through which the waters of the canal were to be carried under and across the bed of the river from the right to the left bank. The Secretary of State for India, at the request of the Government of India, decided to adopt a level crossing. The construction expenditure rose steadily from Rs. 1,00,000 in 1906-07 to Rs. 44 lakhs in 1912-13. The ceremony of opening the canal for irrigation was performed by His Honour Sir Louis

TRAMWAYS AT WORK IN THE MANGLA CUT, UPPER JHELUM CANAL. Plate 1.



The upper portions of the cut were removed by hand and donkey. The next lower lifts were removed by tramway plant and locomotives. The pipal tree seen in the middle distance has been preserved as an emblem of the past.

STEAM NAVVIES AND BROADGAUGE RAILWAY PLANT WORKING IN THE MANGLA CUT. Plate 2.



The lowest li[illegible]e cut were accomplished by means of such navvies and broadgauge plant.
These British ma[illegible] steam shovels were powerful adjuncts to progress and proved quite satisfactory.

Dane, the Lieutenant-Governor of the Punjab, on the 12th of April 1913. The canal system was not then quite completed, but it was possible to take into the canal some water from the river Ravi for irrigation and colonization. In the year 1916-17 the revenue earned was over Rs. 9½ lakhs. On the 31st March 1917 the Capital Account was closed.

CHAP. I.

History of the Project.

CHAPTER II.—Description of the Tracts Irrigated by the Triple Canal System.

THE JHECH DOAB.

The river Jhelum after emerging from the Himalayas, cuts through a range of low foot-hills about 30 miles down its course. This is known as the Salt Range on the right of the gap and as the Pabbi Range on the left. The Pabbi Hills form the main watershed between the Jhelum and Chenab Rivers. There are numerous torrents, which carry into the rivers the rainfall flow off from the hills.

The soil of the Doab is generally a rich loam, interspersed with sandy dunes formed by deposit from the torrents along their course. While 94 per cent. of the Gujrat Tehsil is cultivated, the percentage drops to 70 in Kharian Tehsil and 50 in Phalia Tehsil. The Chenab River margin is well populated and studded with villages and irrigation wells, with spring level from 12 to 15 feet below surface. The ' Bar,' though largely settled, is not cultivated throughout. The depth of spring level increases in proportion to the distance from the river and irrigation by lift diminishes. The average annual rainfall drops from 27 inches in the north-east to 18 inches in the south-west. In ordinary years the crops are good, but scarcity occurs at periodic intervals, the rainfall being scanty and variable in some years.

The total area commanded by flow is 741,600 acres, of which 704,500 acres are culturable and irrigable. The Project aims at irrigating annually 345,000 acres. The area of Crown waste suitable for colonization is about 45,000 acres, out of 388,000 acres of ' Bar ' land, which is privately owned.

THE UPPER RECHNA DOAB.

The main line of the Upper Chenab Canal is conducted, from the river valley at Merala at a gradient of 1 in 6666 on to the watershed of the Rechna Doab; and from about mile 27 of the main canal, the Raya Branch is conducted across the Doab, or watershed, at a gradient of 1 in 5000. All the land lying between these alignments and those of the Lower Chenab Canal, which offtakes from the River Chenab at Khanki 35 miles downstream of Merala, is irrigable by the Upper Chenab Canal. The total area commanded by gravitation flow from Upper Chenab Canal is 1,609,000 acres, of which 2/3rds lies in the ' Bar ' or uplands and ⅓rd in the Khadir or valley of the Chenab and Ravi Rivers. This commanded area may be conveniently considered in three parts, *viz.*, the Bar or upland, and the Khadir of the Chenab and Ravi rivers, respectively.

CHAP. II. — Description of the Tract Irrigated by the Triple Canal System.

In the Bar the soil of a large part of the Daska Tehsil, though mainly dependent on irrigation from wells, is of marked fertility. From here onwards, down the Doab, the soil diminishes in quality. The annual average rainfall diminishes from 25 inches near Gujranwala to 12 inches at the lower end of the canal system. The level of the sub-soil water table sinks from 20 feet below ground surface to 60 feet below ground surface; and well-irrigation, which comprises nearly 75 per cent. of the cultivation in the Daska Tehsil diminishes to only 25 per cent. towards the tail of the canal system.

The tract traversed by the Deg Nala suffers much from the presence of saltpetre in the soil. Over a small northern section the soil is a light loam, naturally most, and requiring little irrigation. Proceeding downwards the tract is found to decline in fertility. The land becomes stiff and sour, and, except where the fertilizing silt of the Deg is deposited by means of diverting cuts and embankments, the labour and expense involved in successful agriculture is relatively great. Towards the south about 75 per cent. of the land lies waste; such cultivation as there is depends mainly on well-irrigation, supplemented by occasional inundation from the Deg Nala. The rainfall declines from 25 to 16 inches and the water table sinks from 20 to 40 feet below ground surface. The soil generally is suited for rice cultivation.

In the *Khadir* of the river Chenab the conditions are fairly uniform. The soil is of stiff clay liable to exhibit salt efflorescence. The average annual rainfall is about 20 inches, spring level is within about 20 feet of the ground surface, and cultivation is practised with irrigation from wells.

Generally over the Upper Rechna Doab the population diminishes in proportion to the annual rainfall and in inverse ratio to distance from the Himalayas; vegetation declines in a similar manner, and the depth below ground surface of the water table increases until it becomes difficult and unprofitable to draw the water up to the surface for purposes of irrigation. Although a fairly considerable proportion of the cultivation is protected by well-irrigation the area annually sown expands and contracts with the varying conditions of the rainfall.

There are traditions of ancient canals irrigating this tract and traces of such works long since fallen into disuse. There was the Ali Mardan Khan Canal, dug 300 years ago to supply water from the Jammu Tavi to the Imperial gardens at Sodhrah near Wazirabad. The Kilri Cut from the Alk Nala is another canal of Mogul times. It was used to convey water to the tank at Sheikhupura, which has a water spread of 26 acres and a

CHAP. II.

Description of the Tracts Irrigated by the Triple Canal System.

maximum depth of 30 feet. From it a canal was conducted down the watershed of the Doab to a point 20 or 30 miles below Sangla Hill. In more recent times one of Ranjit Singh's Ranis cut a canal from the Deg Nala to irrigate her property in the vicinity of Sheikhupura.

THE LOWER BARI DOAB.

The area commanded by the Lower Bari Doab Canal is 2,574 square miles. Of this total 1,342 square miles from the central upland or *Bar*, while 432 square miles are in the *Bet*, or low lands bordering on the river Sutlej, and 800 square miles are in the low lands bordering on the river Ravi.

The Ganji Bar is the name by which the uplands of this Doab are locally known. The soil is generally less culturable than that of the *Sandal Bar* of the Rechna Doab on the opposite side of the Ravi. There are extensive tracts of hard bald stiff clay and towards Multan low sand-hills, or dunes, are much in evidence. Over the greater portion of the Doab, however, the soil is fertile and suitable for irrigtion. The greater part of the country is covered with scrub jungle, chiefly of *jal* or *van* (salvadora oleoides). The rainfall on the Lower Bari Doab is scanty, the atmosphere dry, the depth of the sub-soil water table below the ground surface is great; and the water drawn from the wells is often brackish and unfit for artificial irrigation or for drinking. The few indigenous inhabitants were known as *janglis*, and their chief occupation was cattle-lifting. The photograph facing this page represents the appearance of the *Bar* before it was irrigated and colonized. The average annual rainfall decreases rapidly from 19 inches at Lahore to 7 inches at Montgomery and to 6.25 inches at Multan. About $\frac{3}{4}$ of the total fall occurs during the summer monsoon and $\frac{1}{4}$ in the winter. Cultivation even of the lighter crops, *til* and *bajra*, was possible only in local depressions where rain water accumulated. Spring level was down 60 feet below the ground surface and irrigation from wells was not possible owing to the depth of spring level and the brackish character of the water.

The conditions in the low land bordering on the river Sutlej were very similar to those of the *Bar*. The chief difference was that owing to the ground surface being at a relatively lower level the water table was closer to the surface in this riverain land. Here cultivation from wells was therefore more practicable and was practiced in a few favoured spots, which were populated.



Here the 'Bar' is seen in its natural condition before the introduction of canal irrigation.
At this site the jungle growth in the foreground is less than usual. The ragged clumps of trees are characteristic.

CHAP. II.

Description of the Tracts Irrigated by the Triple Canal System.

In the Ravi *Khadir* or riverain bordering on the Ravi cultivation depended on river spills supplemented by small inundation canals and wells. The floods in the Ravi have been uncertain and irregular, and since the construction and working of the Upper Bari Doab Canal, during the last 50 years, the flow of the river Ravi below Lahore has been very scanty during the winter. In consequence, the inhabitants of the scattered villages of the tract have been in a bad way, and a considerable proportion of the population has migrated to the adjacent Chenab Colony.

The tracts served by the Triple Canals Project lie in the Gujrat, Gujranwala, Lahore, Montgomery and Multan Districts. Though the agricultural conditions varied considerably, getting worse towards Multan, there was one consideration common to all these tracts. There was need for canal irrigation and this need has been met by the construction of the Triple Canal Scheme.

CHAPTER III.—Distribution of Irrigation Facilities per Unit of Area Commanded.

Tabulated below are the areas (in acres) which were comprised in the Triple Canal Project :—

Canal.		Commanded areas.		Areas to be irrigated annually.			
		Gross.	Culturable.	Kharif	Rabi.		Annual Total.
					First watering only.	Whole season.	
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Upper Jhelum	...	741,600	704,520	172,480	20,000	152,480	344,960
Upper Chenab	...	1,608,616	1,528,187	324,184	67,333	256,857	648,367
Lower Bari Doab	...	1,647,218	1,400,138	441,264	16,000	425,264	882,528
Totals	...	3,997,434	3,633,845	...	...	...	1,875,855

UPPER JHELUM CANAL.

The commanded tract has been divided into two zones representing respectively the *Bar* and *Bet*, or upland and lowlands. In the *Bet* or lowland the water table was generally less than 25 feet from the surface, provision was made for irrigation during the kharif or summer season only. The distributaries supply water to these areas are closed during the rabi season. Perennial irrigation has been provided for the *Bar* areas where spring level is more than 25 feet below ground surface. The extent of canal protection is such that at least 75 per cent. of the culturable area will be irrigable annually in the perennially irrigated tracts, and 20 to 25 per cent. in the non-perennially irrigated tracts.

UPPER CHENAB CANAL.

In the Report on the Triple Canal Project the following forecast was made of irrigation from the Upper Chenab Canal :—

Nature of land.				Gross commanded area.	Culturable commanded area.	Annually irrigable area.
				Acres.	Acres.	Acres.
Bar	...	...	...	1,038,504	986,379	425,111
Bet	...	...	...	570,112	541,608	223,256
		Total	...	1,608,616	1,528,187	648,367

And it was assumed that the areas irrigated in the kharif and rabi seasons, respectively, would be as follows :—

CHAP. III.

Distribution of Irrigation Facilities per Unit of Area Commanded.

Nature of land.	Kharif area.	Rabi area.		Total rabi area.	Total annual area.
		Perennial channels.	Kharif channels.		
	Acres.	Acres.	Acres.	Acres.	Acres.
Bar	212,556	180,223	32,333	212,333	425,111
Bet	111,628	76,628	35,000	111,628	223,256
Total	824,184	256,851	67,333	324,184	648,367

2. In the year 1911 it was decided to allow rabi irrigation in tracts where the spring level was within 30 feet of the ground surface. The entire area commanded by the Upper Chenab Canal was divided into zones whose boundaries were determined by the depth of spring level below ground surface, *viz.*—

Zone A, where spring level was more than 35 feet deep.

Zone B, where spring level was between 30 feet and 35 feet deep.

Zone C, where spring level was less than 30 feet deep.

Cultivators in Zone A were to be allowed to irrigate annually 75 per cent. of the culturable area of their holdings, including areas already irrigated by wells.

Cultivators in Zone B were to be allowed to irrigate annually 75 per cent. of the culturable area of their holdings, after deducting from that area all areas already irrigated by wells.

Cultivators in Zone C were to be allowed to irrigate in the kharif season only, and were to be allowed water sufficient to irrigate in that season 25 per cent. of the culturable area outside areas already irrigated by wells.

3. A conference was held at Simla on the 14th August 1911 at which the following programme of future irrigation was forecast :—

Canal.	Kharif area.	Rabi area.			Annual irrigation.
		Perennial channels.	Kharif channels.	Total rabi.	
	Acres.	Acres.	Acres.	Acres.	Acres.
Main Line ..	205,360	209,875	13,088	222,964	428,324
Raya Branch ...	108,199	...	21,640	21,640	129,839
Nokhar Branch ...	19,509	...	...	...	19,509
Total ...	333,068	209,875	34,728	244,604	577,672

CHAP. III.

Distribution of Irrigation Facilities per Unit of Area Commanded.

The kharif area arrived at (333,068 acres) was about 9,000 acres greater than that of the original Project; but the rabi area (244,604 acres) was about 80,000 acres less than that of the original Project; so that the annually irrigable area, thus forecast, was about 70,000 acres less than that of the original Project.

4. Difficulties arose in irrigating according to the zonal system that was established in 1911; and another conference assembled at Lahore on the 30th April 1918, and came to certain conclusions on the subject. Another informal committee met at Simla on the 8th October 1918, and agreed—

> "To adopt a scheme by which canal irrigation would be allowed to well areas in Zone B, its present sanctioned total percentage of irrigation being retained, and the zamindars being allowed to put their irrigation in their well lands if they wished; and also to allow canal irrigation to well areas in Zone C, likewise retaining for that zone its present sanctioned total percentage of irrigation."

At a further Conference, held in August 1920 the following detailed recommendations were agreed to:—

(*a*) *Nokhar Branch*—

(1) Irrigation of 20 per cent. of the total culturable commanded area (including well lands) to be provided for, a full supply factor of 60 acres per cusec being adopted. As a higher full supply factor will suffice on well lands this is expected to result in 25 per cent. of the culturable commanded area being irrigated annually.

(2) The prohibition of irrigation of well lands to be cancelled.

(3) A uniform percentage of irrigation to be provided for over the whole Branch.

(*b*) On the Raya Branch it was agreed that a full supply factor of 60 acres per cusec should be adopted and provision made for a uniform percentage of irrigation over the whole branch of 25 per cent. of the culturable-commanded area, the embargo on canal irrigation of well lands being removed.

This will necessitate an increase in the capacity of the branch from 1,391 cusecs to 1,793 cusecs.

(*c*) For Main Line Lower distributaries the same recommendations were made as for the Raya Branch for the kharif distributaries.

For B Zone channels, which are perennial, it was agreed that the prohibition against irrigation of well lands should be removed and a uniform intensity of annual irrigation of 50 per cent. of the culturable commanded area adopted. It was agreed that the full supply factor should be 80 acres per cusec, and that 50 per cent. of the annual irrigation should be done in each harvest.

CHAP. III. — **Distribution of Irrigation Facilities per Unit of Area Commanded.**

A further important recommendation was that the differentiation of irrigation should be by distributaries, *i.e.*, the whole area of land commanded by one distributary should get irrigation on the same basis which should be that applicable to the zone which predominated within the irrigation boundaries of the distributary.

LOWER BARI DOAB CANAL.

In this case the whole of the commanded tract, with the exception of that irrigated from the Gugera Branch, has been provided with perennial irrigation to the extent of 65½ per cent. annually of the culturable, or 55⅜ of the gross area.

In the case of the Gugera Branch there was a risk of waterlogging some of the land if the same provision of water supplies was made as for the high *Bar* land. For various reasons it was found impracticable to give the lands kharif supplies only, and accordingly perennial irrigation was provided for on the calculation that 50 per cent. of the gross area would be irrigated annually, 28½ per cent. in the kharif season and 21½ per cent. in rabi.

The rabi supplies are to be given for 45 days only from 1st October to 31st March.

This arrangement will permit of free sub-soil flow of drainage across the irrigation channels for long periods each year and thus reduce the risk of raising the sub-soil water table unduly.

CHAPTER IV.—Descriptive.

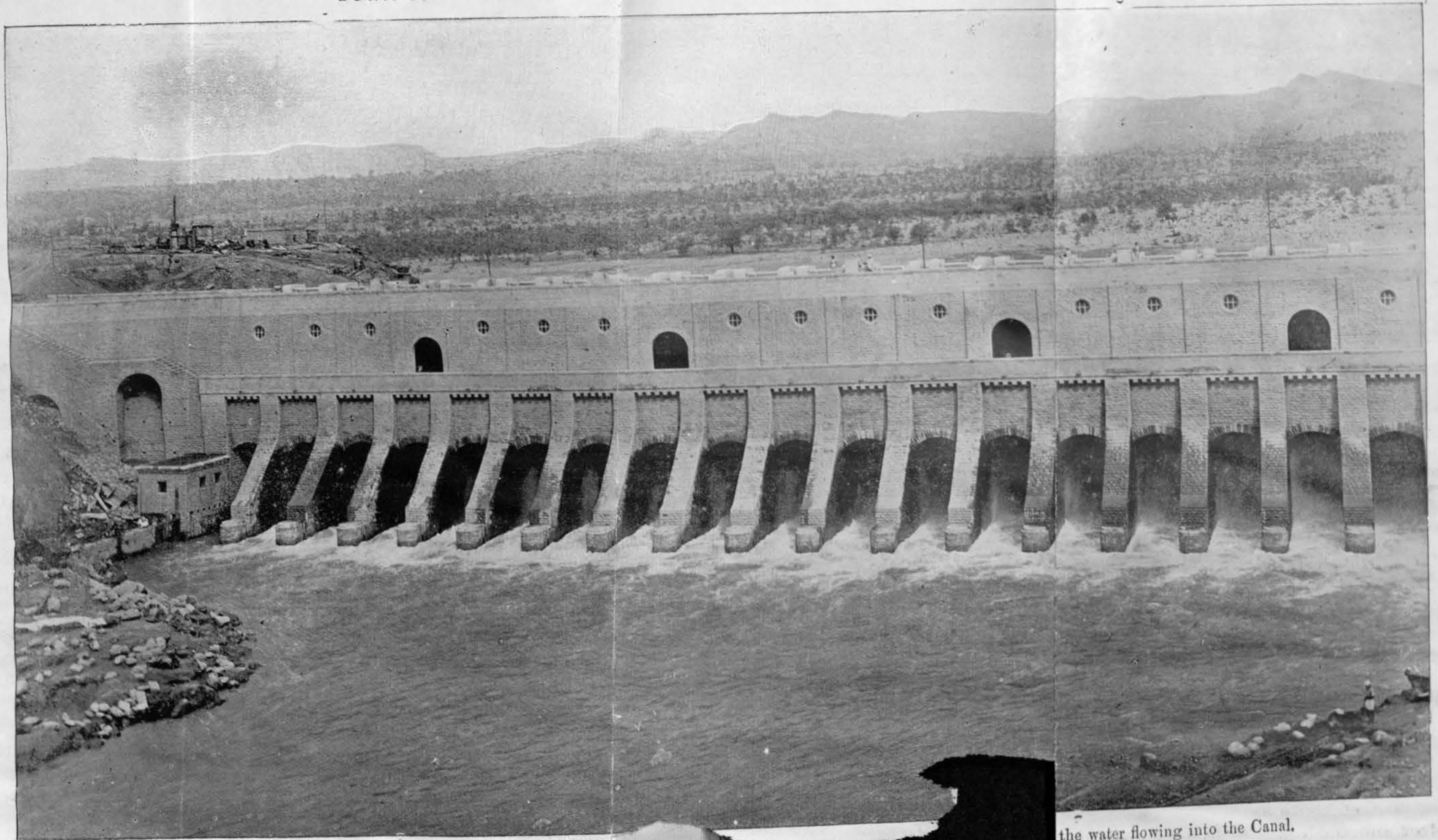
The Upper Jhelum Canal takes off from the river Jhelum at Mangla, on the left bank, and is designed to convey water from that river and to deliver it into the River Chenab above the Weir at Khanki. The Upper Chenab Canal taking off at Merala on the left bank of the Chenab is designed to convey from the river Chenab a quantity of water equal to that made available by the transfer of the Jhelum surplus, right down to the Ravi, and across it to feed the Lower Bari Doab Canal. The three older colony canals, *viz.*, the Lower Jhelum, the Lower Chenab and the Sidhnai, taking off lower down the three rivers respectively have prior claims to the water supplies of these rivers. In the present publication, only the three new canals will be described.

UPPER JHELUM CANAL.

The canal takes off at Mangla, in Kashmir territory, at the cnncave side of a sharp bend of the river. The bank there is a vertical cliff about 100 feet high composed of alternate layers of soft rock and indurated clay. The river bed is scoured deep along the face of this cliff, whilst further downstream, where the river emerges from the hills and widens out in the low lands, a bar of shingle and boulders has been formed in the bed of the river by deposit from the current. The existence of this natural bar in the river bed rendered the construction of an artificial weir across the river unnecessary. The canal is fed from the deep pool in the river at the offtake whose minimum level of water surface is high enough for the purpose. A photograph of the Head Regulator of the canal faces this page. The structure is unusually high by reason of the great variations of water surface level in the river. There was a difference of 41 feet between low water level and maximum flood level in the river before the canal was opened for irrigation. The Head Regulator has 20 vents, each 12 feet wide and in order to cope with the varying water surface levels of the river the vents are controlled by means of 3 tiers of gates working one above the other. The roadway over the regulator is at reduced level 917 or 66 feet above the floor. The length of the regulator is 562 feet and the width at base 67 feet.

The canal has been designed to carry 8,500 cubic feet per second at its head and to deliver 7,700 cubic feet per second at its tail above the Khanki works at the head of the Lower Chenab Canal The bed width is over 200 feet and depth of water nearly 10 feet. Taking out in deep cutting from the river at

DOWN STREAM FACE OF THE MANGLA REGULATOR, UPPER JHELUM CANAL.



As viewed from the top of the Mangla Cut, this work appears ... the water flowing into the Canal.
To the left of the picture can be seen ... power h... ...ulator and the Canal Station.

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a Lay

Mangla the Upper Jhelum Canal follows a south-east course for 15 miles, along the slope of the Pabbi Hills, crossing a large number of torrents. Thence its course is south-west to Rasul at mile 50, passing in quick succession through deep cuttings and high embankments and crossing numerous torrents. As the canal gradient is very much flatter than that of the river, the difference between the bed of the canal and that of the river gets greater and greater, until at Rasul there is a difference of close on 80 feet. Here the canal curves sharply to the left round the extreme spur of the Pabbi Range, and takes an easterly course for 12 or 13 miles, along the southern slopes of the hills, passing across more torrents. Thereafter its course is generally south-east down to its outfall into the river Chenab at mile 89. In this last reach the canal gradually receded from the hills and the torrents crossed are of deltaic formation.

The main feature of this canal is its numerous crossings of torrents. There are 60 of these torrents meeting the 89-mile length of canal. Fifty-five of them have been passed across or under the canal whilst five have been discharged into it.

The last torrent encountered is the Bhimbar, which meets the canal alignment at mile 83. From there to mile 89, where the canal ends, the channel is 1,300 feet wide, between its two banks.

The canal throws off one Branch, called the Gujrat Branch, which takes out at mile 57, right bank, for irrigating the *Bar*. It is 37 miles long.

The actual booked cost of this canal, on the 31st March 1917, when the Capital Account was closed, was Rs. 4,30,11,584 for direct charges and Rs. 4,38,49,947 for direct and indirect charges combined. In that year it brought in a revenue of Rs. 83,631; but it is estimated that the annual revenue will ultimately be over 20 lakhs of rupees. Its earnings are expected to represent a return of 2.85 per cent. on the capital cost incurred on it; but since its main function is to convey water into the river Chenab, for the purpose of irrigating the Upper Rechna and Lower Bari Doabs, the revenue derived by the Upper Chenab and Lower Bari Doab Canals must be included in the reckoning of the financial returns of the Upper Jhelum Canal.

UPPER CHENAB CANAL.

The Headworks of this canal are at Merala, 35 miles upstream of Khanki, on the river Chenab, at a point just below where the last of the Bajwat tributaries enter the river. The

CHAP. IV. — Descriptive.

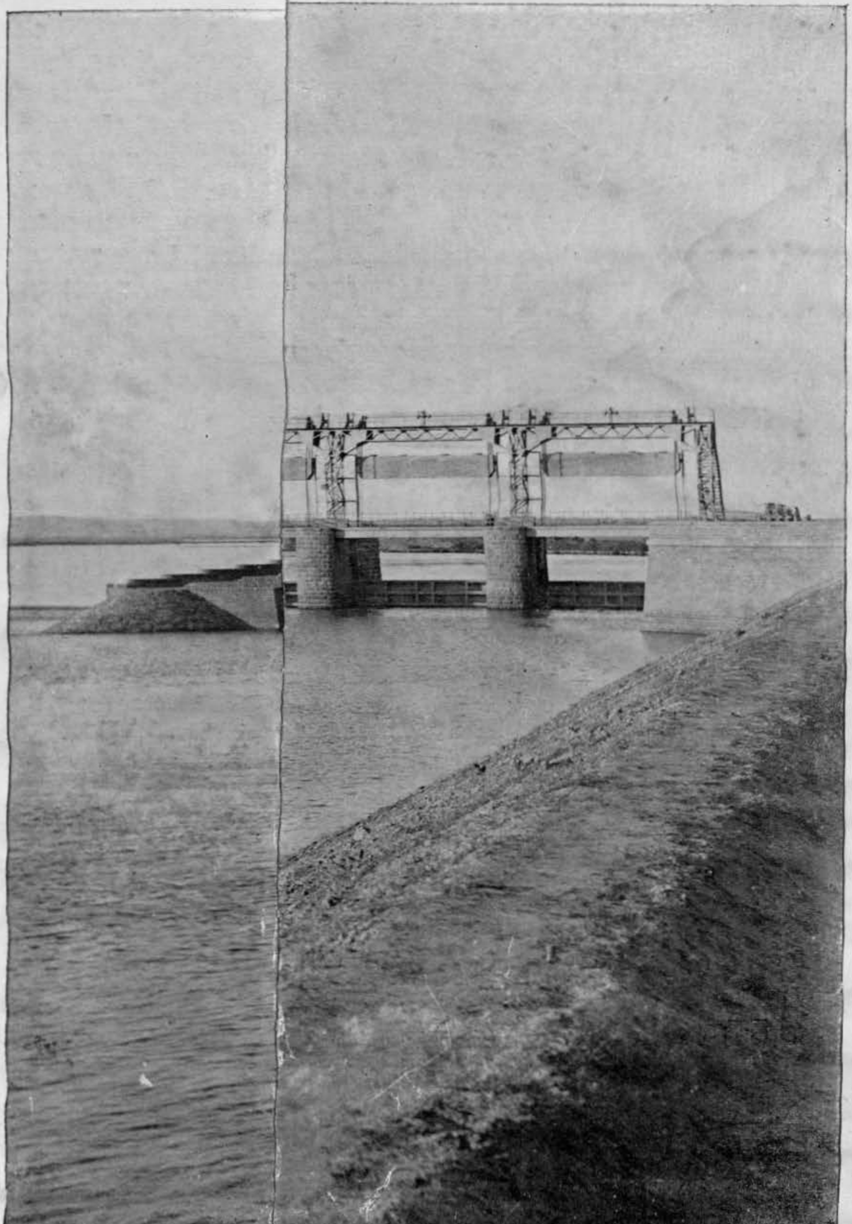
usual group of river works consisting of a weir, undersluices regulator, and training works, have been built here. The photograph facing this page is a view of the sluices from the left downstream bank. The winter discharge of the river falls to a minimum of 6,000 cubic feet per second and it is computed that in high flood there may be as much as 700,000 cubic feet per second passing down. The canal discharge varies between 5,000 and 11,700 cusecs. The level regulator controls the quantity taken into the canal, and the other works control the levels of the water in the river. When the river is low the sluice-gates are closed and the hinged shutters on the crest of the weir are erected; and when the river is high the weir shutters are dropped flat and the sluice-gates are opened.

The canal has been designed to carry 11,694 cubic feet per second, which is many times in excess of the discharge of the Thames at Teddington. It is the largest perennial canal in India. The bed width is 240 feet and the depth of supply 11.1 feet. The main canal at a short distance from the Head Regulator curves to the right, and proceeds generally south-east. It crosses the Sialkot Branch, North-Western Railway, near Sambrial, and a number of lines of drainage flow in its first 27 miles. At mile 27, about 4 miles west of the Tehsil town of Daska, it trifurcates. The Nokhar Branch takes off on the right bank. The main canal continuation, called the main line lower, takes southerly course for a distance of 92.8 miles more to the Ravi opposite Balloki. At mile 19 it crosses the main North-Western Railway, and at mile 52 the Sangla Branch Railway. The canal has been constructed so as to deliver 6,500 cubic feet per second at its tail, into the Ravi, for use in the Lower Bari Doab on the other side of that river. The bed width here is 160 feet and the depth of supply 10 feet.

The canal has 2 branches and 33 distributaries of an aggregate length of 1,200 miles.

In the first 24 miles of the Main Line Upper 12 drainage crossing works were required. Four of them have been built of brick masonry and eight of the new building material, reinforced concrete. This was the first instance in the Punjab of reinforced concrete construction on a large scale. Between mile 70 and mile 80 of the Main Line Lower the Deg Nala is met with. The floods down this group of drainages is estimated to be close on 35,000 cusecs. It has been arranged to divert this flow into the Ravi a short distance south of the Tehsil town of Sharakpur.

The capital expenditure booked against this canal on the 31st March 1917, when the account was closed, was



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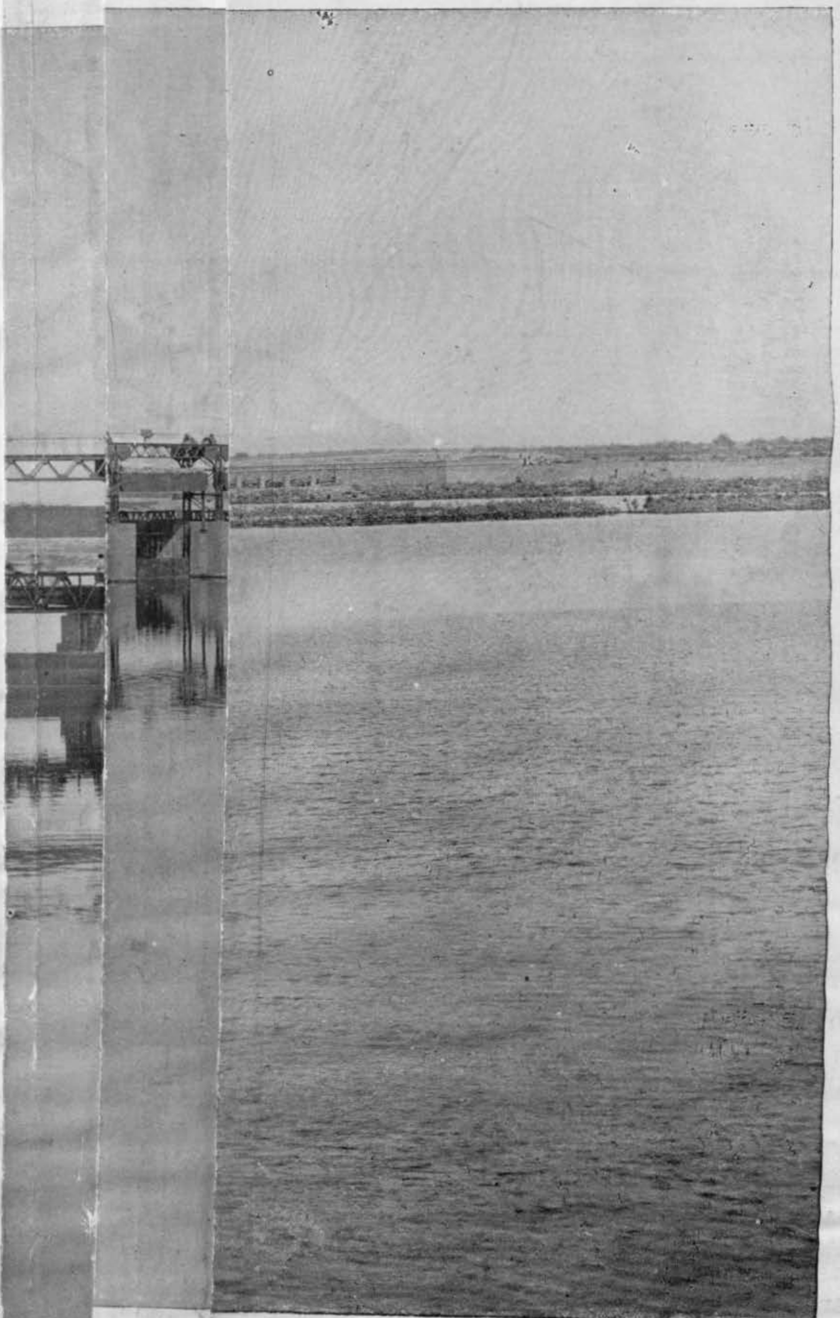
This full l[illegible] graph conveys an excellent idea of the size of this wo

LOWER BARI DOAB CANAL
PANORAMIC VIEW OF BALLOKI LEVEL CROSSING.



rk. There are 35 spans each 40 feet clear. On the left is the Canal Head Regulator of which the roadway, lifting gear and operating gangway can be seen. In t

Plate 6.



rk. Th he distance

Rs. 3,53,42,184 for direct and indirect charges combined. The revenue earned was Rs. 1,35,507 in 1912-13, the year in which it was opened, and Rs. 25,63,550 in the year 1916-17.

LOWER BARI DOAB CANAL.

The Headworks of this canal are in the form of a level crossing, where the supply delivered by the Upper Chenab Canal into the river Ravi on the right bank, crosses it at bed level and is taken off again on the left bank. The group of works consists of an inlet, a barrage, a regulator, and training works. The photograph opposite is of the Balloki Level Crossing. The discharge of the river Ravi at Balloki varies from a minimum of *nil* in the winter and to a maximum flood of 150,000 cubic feet per second in the monsoon. The Upper Chenab Canal has been designed to deliver 6,500 cusecs into the Ravi at this site. The barrage across the river has 35 openings each 40 feet wide. Its gates are 12.5 feet high, and have counterbalance weights which ensure a saving on the power of the machinery required to move the gates up or down quickly.

From Balloki the canal, for about 30 miles, proceeds in a generally south-west till it approaches the North-Western Railway near Satgara. Thereafter to the tail, at mile 134, the canal follows the main water-shed of the Doab, on a course nearly parallel to, and on the west of, the Railway line.

The canal has been designed to carry 6,500 cubic feet per second at its head; has one branch running down the Ravi Khadir, and 30 distributaries of a total length of 1,000 miles.

On the 31st March 1917, when the Capital Account of the Canal was closed, its total cost had been Rs. 2,18,74,263 for direct and indirect charges. It was opened for irrigation in 1913-14, and in that year the income was Rs. 42,190. In 1916-17 the income had risen to Rs. 9,64,893. This will be most paying section of the Triple Canals Scheme. It is estimated that this canal will in due course bring in a gross annual income of over 56 lakhs of rupees.

THE TRIPLE CANAL SYSTEM AS A WHOLE.

In the table at Appendix 'A' will be found the details of capital cost of the Triple Canal, down to date of closing the Account, on 31st March 1917. From the statement it will be seen that the total direct and indirect expenditure, including the sum of Rs. 14,08,692 expended on watercourse construction and recoverable ultimately from the settlers, was Rs. 10,10,66,394. In the year 1916-17, when the account was closed, the gross revenue was Rs. 36,12,074, representing a net

INSPECTION HOUSE AT GUJRANWALA AS SEEN FROM THE NORTH EAST.



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CHAP. IV.
Descriptive.

There are 92 telegraph and 15 telephone stations. Flood warning stations have been established up the rivers to give the local engineers warnings of the approach of floods.

Rest-houses for the use of inspecting officers on tour have been built over the whole system. There are 35 on the Upper Jhelum Canal, 48 on the Upper Chenab and 54 on the Lower Bari Doab. As the total commanded area is 6,246 square miles, there is one rest-house to about every 45 square miles of country. The illustration facing this page is a photograph of the rest-house at Gujranwala.

Bridges for the convenience of the people have been built on the canal system on the average of one to every two miles on the Main Canals and Branches for the settled tracts on the Upper Jhelum and Upper Chenab Canals. On the Lower Bari Doab Canal the provision of bridges is only one to every 3.5 miles; the colony villages having been located in such a way as to reduce to a minimum the number of bridge crossings required by the colonists.

CHAPTER V.—Colonization.

The gross areas commanded by the Triple Canal System are as follows:—

		Square miles.
Upper Jhelum Canal	...	1,159
Upper Chenab Canal	...	2,513
Lower Bari Doab Canal	...	2,574
Total	...	6,246

About 90 per cent. of these areas are culturable; and out of them 3,550 square miles are uplands, distributed through the three Doabs in the following manner:—

		Square miles.
Upper Jhech Doab	...	608
Upper Rechna Doab	...	1,600
Lower Bari Doab	...	1,342

The areas of Crown waste, which are to be colonized are:—

		Acres.
Upper Jhech Doab	...	45,000
Upper Rechna Doab	...	81,000
Lower Bari Doab	...	1,309,220
Total	...	1,435,220

The areas of Crown waste amount to 2,242 square miles, or 36 per cent. of the gross commanded area.

During the years 1903-05 the commanded areas in the Jhech and Rechna Doabs were traversed by parallel lines of level survey spaced 1,100 feet apart; and points 990 feet apart along these lines were marked by stones let into the ground; which

thus demarcated the whole area into rectangles measuring 1,100 feet by 990 feet. The same had been done in 1900-01 in the Lower Bari Doab. The entire tract to be served by the Triple Canal System Crown waste and settled villages alike, was thus divided up into rectangles of exactly 25 acres each which formed the unit areas of allotment to colonists. Levels were observed at intervals of 550 feet in one direction and 495 feet in the other direction a very complete and elaborate contoured plan prepared from the levels thus observed. The alignments of the various channels were designed on the plans to follow the main and subsidiary water-sheds, and the aim was to command every acre of ground by gravitation or surface flow. The water-courses were designed to follow the sides and diagonals of the rectangles, the unit for colonization being one rectangle of 25 acres. The colonists were required to sub-divide each main rectangle subsequently into 25 *killas* or sub-rectangles, each one acre in area.

When the canals were approaching completion colonization began. In the Jhech Doab the settlement operations in the Gujrat District of 1911-12 preceded the opening of the Upper Jhelum Canal in 1915. Similarly in the Rechna Doab the settlement of the Gujranwala and Lahore District of 1906-08 preceded the opening of the Upper Chenab Canal in the year 1912. On both these canals are areas to be colonized and settled, being small, the work was done by the District officers. In the Lower Bari Doab a special officer was appointed to superintend the work of colonization which has since proceeded *pari-passu* with the completion of the channels and the gradual increase in the water-supply available for irrigation. The Colonization Officer's annual reports give full details of the soil survey and other preliminary work; of the conditions of grants, of the selection of colonists, of the allotment of rectangles, of all the many difficulties encountered and overcome and of the progress of the colony from the commencement of operations to the present time. It is not intended to go over the same ground here, but only to give a brief resume of the main features of the latest reports, *viz.*, those of 1917.

UPPER JHELUM CANAL COLONY.

The colony consists of 32 *rakhs* or Government Forest Reserves, in which the main rectangles were laid out in 1911-12 along with those in the proprietary village lands almost all the *rakhs* being interspersed with old village lands. The *killabandi*, or sub-division of the rectangles into one-acre plots, was completed in 1916.

CHAP. V.
Colonization.

The following are the details of colony allotment down to end of 1917 :—

		Acres.
Horse breeding grants	...	7,212
Preferential grants	...	4,107
Compensatory grants made to men in the Rawalpindi Division for assistance in Criminal Administration	...	8,240
Military reward grants	...	264
Reserved for Dairy and Agricultural seed farms	...	1,250
Reserved for Plantations and Forests	...	7,200
Total	...	28,273

leaving about 15,750 acres unallotted; of which about 20 per cent. of the total, or 9,000 acres, have been reserved for *Charagah* or grazing grounds (village common land).

Arrangements are being made to establish a market town at Baha-ud-din, near Rasul.

UPPER CHENAB CANAL COLONY.

The following are the areas of this colony :—

		Acres.
Total areas of Crown waste	...	85,568
Allotable area	...	80,725
Culturable (irrigable) area	...	78,892
Area allotted	...	56,350
Balance unallotted	...	24,375

The total allotable area has been divided into 50 *chaks* of which 9 fall within the zone of perennial irrigation, while 41 will receive only irrigation in the kharif season. This makes colonization somewhat difficult, as non-perennial irrigation is not attractive to colonists.

Allotments have been made to purchasers by public auction, to peasants and compensatory grantees, for regimental horse-runs, and as rewards for public services. Here, as elsewhere, it has been found that where residence is not a compulsory condition of the grant, the grantees do not make good colonists.

One rectangle, in a few cases more, has been set aside for the *abadi* or residential village site in each *chak*. The position selected for the *abadi* has usually been the highest in the *chak*.

LOWER BARI DOAB CANAL COLONY.

The areas to be dealt with in this colony are:—

		Acres.
Total areas of Crown waste	...	1,309,220
Allotable area	...	1,125,625
Culturable and irrigable area	...	1,068,939
Area allotted to September 1916	...	407,321
Balance unallotted	...	718,304

The whole area commanded was divided up into 25-acre rectangles and in the year 1919, Mr. I. C. Lal carried out a survey to determine the quality of the soil in each rectangle. According to this survey an area of 163,000 acres was reported to be unfit for cultivation, but according to a later survey, conducted in 1915-16 by Mr. Joseph, Colonization Officer, the area of bad soil reported to be was to be 300,000 acres instead of 163,000.

This later soil survey was made in great detail, the *killa*, or 1-acre sub-rectangle, being the unit.

The scheme of colonization sanctioned by the Government of India contemplated the following general disposal of land, the details being subject to alterations from time to time—

		Acres.
For forests	...	40,000
Sale by auction	...	125,000
Regimental farms and other special agricultural objects	...	100,000
Horse and mule breeding	...	680,000
Grantees from congested districts	...	80,000
Hereditary landed gentry	...	75,000
Compensatory grants to persons whose land has been lost by diluvium or expropriation	...	40,000
For depressed classes	...	30,000
Reward grants	...	22,000

The great attractions of a new colony, fully equipped from the outset with complete facilities for irrigation and cultivation, have the effect of drawing away tenants from the surround-

CHAP. V. Colonization.

ing settled tracts. Grantees are prohibited from employing tenants from proprietary village lands in the adjacent riverain tracts.

The allotments made fall under the following heads:—

		Acres.
Disposed of by auction sales	...	37,583
Allotted to farms for horse breeding and special agricultural objects	...	71,882
To *abadkars* (peasant colonists)	...	268,133
Irrigated arboriculture in 2 blocks	...	29,723
Total	...	407,321

The area cultivated in the permanently allotted tract during 1915-16 was:—

		Acres.
Kharif 1915	...	78,925
Rabi 1915-16	...	119,631
Total	...	198,556

The crops in 12.4 per cent. of these areas failed to mature up to the recognized standard of average yield.

During the same year cultivation by temporary grantees was permitted on the unallotted tracts, and 43,899 acres were cropped by them.

Crown waste land has been parcelled out into 754 *mauzas* or *chaks* or villages. *Abadi* sites were allotted and demarcated in 411 villages. The *khaka* or ground plan of *mauza* Mian Khaira (No. 98) shows the arrangements of the watercourses, roads, *abadis* and *charagah* reserve (*vide* Plate II). In the lay-out great attention has been paid to sanitary considerations.

Towns and markets are springing up at Montgomery, Okara, Chichawatni, Khanewal and Mian Chanun.

In March 1914, 18,669 acres of land were sold by auction, and realized an average price of Rs. 275-12-0 per acre. The price per acre varied, in different lots, from Rs. 209 to Rs. 360.

In February 1915, the prices paid for land, similarly sold, ranged from Rs. 100 to Rs. 330 the average being Rs. 188 per acre. In January 1916 the average price was Rs. 179 per acre. In this case too large an area was placed on the market at one time. These prices refer to culturable land, irrigable by flow. The value of land in markets (*mandis*) factories and towns is much higher. In 1915, at Okara, house-sites fetched Rs. 442 per site, while sites for shops averaged Rs. 1,340. Six shops in the *mandi* ranged from Rs. 1,150 and Rs. 2,100 and nine in the wood market from Rs 375 to Rs. 650 per site.

CHAPTER VI.—Operating Staff.

The Canal establishment consists, in the lower ranks, of two separate classes performing different functions. These are the engineering subordinates who keep the channels and works in good repair and in efficient working order; and there are the revenue officials who are concerned with the proper distribution of the water supply and with the assessment of canal revenue. The Engineers (Assistant and Executive) supervise and control the operation of both classes of establishment; and in administrative charge of a whole canal system or circle is the Superintending Engineer. The Triple Canal System is under the control of three Superintending Engineers, each in charge of one of the canals of that system, under the direction of the Chief Engineer. The Upper Jhelum Canal is less of a revenue and more of engineering charge. The Upper Chenab and the Lower Bari Doab Canals are of the usual type of canal systems in operation and may be regarded as a single canal system divided into two parts by the river Ravi. In the three statements at Appendix B, will be found the names with their dates of holding charge of all the Superintending Engineers who have in the past held charge of the three canals, respectively. The Headquarter stations are Jhelum for the Upper Jhelum Canal, Lahore for the Upper Chenab Canal and Montgomery for the Lower Bari Doab Canal.

Each Superintending Engineer is general manager of his canal system; he controls the operating staff, aranges for their leave, postings and transfers within his jurisdiction, and awards praise or punishments within certain limits of discretion. He controls the equitable distribution of the available water supply of his canals; he regulates the allotments of funds for expenditure and sanctions expenditure according to estimates of the cost of works of construction or repairs; and he deals with appeals in canal assessment matters. His charge is known as a Circle; which is divided into Divisions, in charge of Executive Engineers, and Sub-Divisions in charge of Assistant Engineers or selected Subordinates.

UPPER JHELUM CANAL.

This canal comprised two Divisions in March 1905, when construction was first started. The number of Divisions was increased to six as construction progressed; and was later on reduced to 4. The Jhelum Division, with headquarters at Jhelum, is a purely engineering charge, extending over the first 52 miles of the canal. There are .4 sub-divisions in the Jhelum Division including one in charge of the canal railway and

quarries. The regulation of the water supply and the upkeep of the water account of the five perennial canals interested in the flow of the Jhelum and Chenab rivers is a part of the duties of the engineer in charge of this division. There is no irrigation from the canal in this division in British territory. There is irrigation from it in the lands of the Kashmir State between miles 8 and 15, but this irrigation is managed by the officials of that State. But though the engineers of this division have no irrigation or revenue work to do they have plenty of work of an engineering nature. In this reach of the canal are situated all the high embankments, and about 80 per cent. of the cross-drainage works. Throughout the summer monsoon and at other periods of rainfall emergencies are liable to occur which threaten the safety of the works.

The next division is called the Phalia Division, with headquarters at Rasul. It comprises the whole of the Gujrat Branch and its distributaries. There are three sub-divisions in this division whose officers have charge of the maintenance of 40 miles of the Branch Canal, 483 miles of distributaries, and 3,200 miles of field watercourses. The area irrigated in this division will probably be about 267,500 acres annually. It will be the main revenue division of the Circle.

Lastly, there is the Gujrat Division, with headquarters at Gujrat. It is divided into 3 sub-divisions. It covers the last 36 miles of the main canal and includes 165 miles of distributary channels, 3 miles of subsidiary embankments and drainage cuts, and about 1,000 miles of field watercourses. About 20 per cent. of the large torrent works, including the Bhimbar Diversion Cut, fall within the limits of this division. There are also river training works in connection with the outfall of the canal into the Chenab upstream of Khanki, and irrigation annually of about 55,000 acres.

In Appendix C will be found the numerical strength of the superior staff, and at Appendix D similar figures of the numerical strength of employees engaged in the Circle. The staff employed on revenue work is referred to elsewhere in this publication.

UPPER CHENAB CANAL.

The Circle was constituted in February 1905 when construction commenced. There were 2 divisions at first, a number which increased to 5 when construction was fully developed. After completion of construction the charges were reduced to 4 divisions with 10 sub-divisions.

CHAP. VI.

Operating Staff.

The first of the former is the Merala Division, with headquarters at Merala, at the head of the canal. There are two sub-divisions, of which one is an engineering charge wholly, while the other includes irrigation and revenue work. The division extends down to the trifurcation at mile 27, and includes the Nokhar Branch, 16 miles long, about 16 miles of subsidiary embankments and cuts, nearly 70 miles of distributaries and 1,155 miles of watercourses. The annual irrigation is expected to be about 32,000 acres. There are a number of masonry works for the passage of surface drainage across the main line of the canal. The Executive Engineer is responsible for the correct division of supply between the Upper and Lower Chenab Canals, and between the Upper Chenab and Lower Bari Doab Canals.

The Gujranwala Division, with headquarters at Gujranwala, comes next; and comprises 3 sub-divisions. It consists of 48 miles of the main canal from the trifurcation, downwards, 457 miles of distributaries and 3,110 miles of watercourses. The annual irrigation is expected to be about 319,000 acres.

Next comes the Sheikhupura Division, with headquarters at the new civil district headquarters, at Sheikhupura. It comprises 2 sub-divisions; and consists of 45 miles of main canal, 291 miles of distributaries, 19 miles of diversion cuts, and 1,630 miles of watercourses. The estimated annual irrigation is 162,000 acres. The management of the diversion of the flow of the Deg Nala is a matter of considerable engineering concern. Higher up, and to the East, is the Raya Division; with headquarters at Gujranwala. It has 3 sub-divisions, and consists entirely of the Raya Branch Canal 35.4 miles long, and 267.5 miles of distributaries offtaking therefrom. There are also 8 miles of diversion cuts and 2,080 miles of watercourses. The protection of a considerable length of channel along the right bank of the Ravi river, and the drainage crossings add to the engineering features of the charge. The annual irrigation is estimated at about 125,000 acres, to be wholly effected in the kharif season.

At Appendix C will be found the numerical strength of the superior establishment; and at Appendix D, similar figures regarding the strength of the staff required for maintenance of work, office work, regulation, telegraph and health. The staff engaged purely for revenue work is referred to elsewhere in this gazetteer.

LOWER BARI DOAB CANAL.

CHAP. VI.

Operating Staff.

The construction of this canal began in October 1906. It constitutes a separate Circle of Spuerintendence, under the care of a Superintending Engineer; and comprises 4 divisions, each under the care of an Executive Engineer.

The Balloki Division, with headquarters at Balloki, at the head of the canal, on the Ravi, is divided into 2 sub-divisions. The charge consists of 33 miles of main canal, 147 miles of distributaries, 56 miles of embankments and drainage cuts, and 832 miles of watercourses. This division has also the control of the barrage across the river, and other river works at Balloki; and the transmission of the water-supply of the river Ravi down to the Sidhnai Canal. The area irrigated annually within the division is close upon 100,000 acres.

The *Okara Division*, with headquarters at Montgomery, comes next down the canal. It has three sub-divisions; and consists of 45 miles of canal, 372 miles of distributaries, 52 miles of embankment and drainage cuts, and 2,643 miles of watercourses. The area irrigated annually within the division will be about 270,000 acres, partly newly-colonized land and partly the land of proprietary villages. The three sub-divisions are nearly of equal size comprising about 90,000 acres of annual irrigation each.

The third is the Montgomery Division, with headquarters at Montgomery. It is divided into 3 sub-divisions and consists of 43 miles of the main canal, 363 miles of distributaries, 3.6 miles of escape, 16 miles of embankments and drainage cuts, and 2,666 miles of watercourses. The culturable commanded area is 409,000 acres, of which about 240,000 acres are irrigated annually, all in the colony.

At the tail end of the Canal System is the Khanewal Division, with headquarters at Khanewal. It has 3 sub-divisions, and consists of 22 miles of main canal, 245 miles of distributaries, 4.5 miles of embankments, and 1,386 miles of watercourses. The estimated annual irrigation will be nearly 200,000 acres, all in the new colony.

At Appendix C will be found the numerical strength of the superior staff; and at Appendix D, similar figures regarding the strength of the establishment required for maintenance and upkeep of the channels, office work, regulation, telegraph and health. The staff employed on purely revenue work is referred to elsewhere.

CHAP. VI.

THE TRIPLE CANAL SYSTEM AS A WHOLE.

Operating Staff.

The entire system commands an area of 3,997,434, nearly 4 million acres; and is designed to irrigate 1,875,855 acres annually but may be expected to irrigate fully 2 million acres. It comprises 3,574 miles of State-owned channels, and 19,629 miles of watercourses and forms three separate circles of superintendance, each in charge of a Superintending Engineer. The 3 circles comprise 12 divisions, and 35 sub-divisions. The work of maintenance of the channels and works is carried on through the agency of 153 Engineering Subordinates and 69 mistris or artificers: while the office work of accounting for expenditure, correspondence, estimating, drafting and drawing is carried out by 135 Accountants and Clerks and 73 Draftsmen and Tracers. The distribution of the water supply is operated by 267 Gauge Readers and 278 Jamadars and Beldars. The auxiliary services for the rapid transmission of orders include 108 telegraph and telephone operators, and a large number of watchmen. The health of the staff and work people is looked after by 24 Sub-Assistant Surgeons in charge of Canal Dispensaries. The revenue work, in the present state of development, is performed by the agency of 10 Deputy Collectors, 55 Zilladars, 549 Patwaris and 177 revenue Munshi (*vide* Appendix J). The correspondence and records of revenue work is done chiefly in the vernacular. All the village field books, maps and files are recorded in the Vernacular Branch of the Executive Engineers' offices under the care of Ahlmads. Translations in English of important vernacular reports, statements and statistics, are prepared by Clerks in the Divisional offices.

CHAPTER VII.—Maintenance and repairs.

The maintenance and repairs of the Canal system involves keeping the earthen channels and masonry works, from the river, down to the field watercourses constantly in a state of hydraulic efficiency. The engineering operations of maintenance and repairs keep in view the improvement of the irrigating efficiency of the canal system with a view to increasing the irrigated area as far as possible with the limited supply of water that is available.

At Appendix C will be found a numerical list of the works subordinates employed on the three canals.

The engineering subordinates do the bulk of the surveying and levelling work. They prepare drawings and estimates, arrange for the manufacture and collection of materials, keep up *Muster Rolls of daily labourers, etc.* They measure up the work done by contractors or by daily labourers and record the results in measurement books and periodical progress reports. They disburse petty sums from Imprests granted to them by Sub-Divisional Officers and maintain the initial accounts of cash, materials, tools and plant.

The Assistant Engineer, Temporary Engineer, or selected Upper Subordinate in charge of a sub-division is responsible for the correctness and accuracy of the work done by the subordinate staff, and is required personally to check the levels of the foundations of important works. He is the main disbursing agent, makes requisitions for funds and renders full account of all transactions including the receipts and issue of materials manufactured, purchased or stocked, and the receipts and issue of tools and plant.

UPPER JHELUM CANAL.

The maintenance and repairs of the entire length of the canal, which is crossed by over 50 hill torrents, is a work of the highest importance and a source of constant anxiety. The training works of the large level crossings, the drainage diversions and the depressed syphon works are likely for ever to be a heavy burden of anxiety and of work during the flood season and whenever heavy rain occurs. The long side slopes of the deep cuttings will call for constant attention and the high embankments will need regular repairs to rain cuts, ravines and slides. The Bhimber Diversion Cut and the outfall river works on the Chenab right bank raise hydraulic problems of a difficult nature. As the whole of the Triple Canals System depends on the water supply conveyed by the Upper Jhelum Canal, this Canal will

CHAP. VII.

Maintenance and repairs.

require special attention and will need to be always kept up to the highest pitch of efficiency. The average annual expenses of maintenance of this system will be about Rs. 7 lakhs.

UPPER CHENAB CANAL.

The river works at Merala form the most important group on this canal. The works providing for the passage of drainage due to rainfall across the canal system are numerous; and arrangements for the prevention of water-logging of the soil due either to obstruction of surface of drainage or to percolation from the canal form an important part of the duties of the engineers in charge of this canal.

The average annual working expenses of this canal are estimated at Rs. 10 lakhs.

LOWER BARI DOAB CANAL.

The most important work on this canal, as well as the most imposing in appearance, is the barrage across the river Ravi at Balloki, at the head of the canal. It has spans, 35 each 40 feet wide, controlled by stoney sluicegates 12.5 feet high fitted with standing gearing and counterbalanced weights. Balloki is connected with Changa Manga, on the North-Western Railway, by means of a canal railway. So far down from the hills the country is flatter and the cross drainage works are less important than elsewhere. But even here the rainfall may at long intervals be very heavy and may bring about considerable additional work.

The average annual cost of repairs on this canal is estimated at Rs. 9 lakhs.

GENERAL REMARKS.

Drainage crossings are examined after the monsoons to see if any works are necessary and once more before the flood season to make sure that the canal works are in a fit state to carry off the drainage without damage.

All earthen channels in the tropics are liable to changes in cross section or discharging capacity from the growth of the side berms and the encroachment of weeds and jungle and their banks are cut up by rainfall. In the larger channels the fluctuations of supply due to the changing nature of the demand and the most suitable method of control may in practice cause the sides to slip. Distributaries which at one time of the year are supplying water proportionately to all outlets down their course are often found in a few months to have lost efficiency in this respect. The bed of the main canal can only be examined when

the whole canal is closed, while the smaller channels can be examined more frequently as they are shut at shorter intervals. Throughout the year every opportunity is taken to examine the condition of the bed and inner slopes to make sure that the channels will continue to perform their proper function efficiently. The condition of channels is never stable. There is constant change and constant scope for remodelling and improvement of design.

CHAP VII.

Maintenance and repairs.

Almost all engineering work is done by piece work or petty contract; some of it by daily labour gangs; but occasionally the canal zilladar requisitions labour from villages in order to repair breaches of channels. The people usually turn out readily enough as they are directly interested in the maintenance of a regular flow of water throughout the canal system.

The Superintending and Executive Engineers are invested with powers of sanctioning expenditure within certain limits, as stated below :—

Head of Account.	Superintending Engineers' powers.	Executive Engineers' powers when in charge of a Division.
Maintenance and repairs ...	Up to limit of sanctioned Budget	Rs. 200 to Rs. 2,500.
Extensions and improvements...	Rs. 5,000 to Rs. 10,000 ...	Rs. 200 to Rs. 2,500.
Establishment	Rs. 100	Work charged.
Tools and Plant	Rs. 2,500 to Rs. 5,000 ...	Rs. 500.
Suspense	Full powers	*Nil.*
Taccavi works	Up to Rs. 10,000 ...	Rs. 200.

CHAPTER VIII.—Water Regulation and Distribution.

(*i*) Regulation.

UPPER JHELUM CANAL.

At Mangla at the head of this canal the water surface level of the river is not held up by means of a masonry weir built across the river, such as has been built across the river at the head of every other perennial canal in the Punjab. The only masonry work at Mangla is the regulator at the head of the canal, through which water is admitted into the canal. The outstanding feature of this regulator is its great height, which is necessitated by the abnormally great difference in river water surface levels between high water and low water. The available water supply of the river has to be equitably shared between the Upper and Lower Jhelum Canals. During eight or nine months of the year there is usually an excess supply in the river and then the Upper Canal can take as much as it needs. But during the winter, or low-water season, when the available supply is not sufficient to fill both canals simultaneously it becomes necessary to divide the water so that during one period the Upper Canal will be taking its full share and leaving a varying balance to go down to the Lower Canal; and during another period a definite supply must be allowed to proceed to the Lower Canal while the varying surplus is being taken in at Mangla for the Upper Canal. The Rules for Regulation of Supply, a reprint of which will be found at Appendix E. (1), take these and other matters into account. The rules require that throughout the flood season an Engineer Officer, the Sub-Divisional Officer, or, in his absence, the Executive Engineer, shall be present at Mangla and manage the regulation of the supply. During the winter when the river is low the officer-in-charge of the regulation at Mangla is required to maintain a daily account of the distribution of the water to the two Jhelum Canals, the two Chenab Canals and the Lower Bari Doab Canal, and to submit a weekly abstract of the water account down to date to the Chief Engineer, the Superintending Engineer of those canals and the Executive Engineers in charge of the headworks of those canals. The volumes of flow of the Jhelum, Chenab, and Ravi Rivers are very variable quantities and all variations of quantity have to be distributed rateably to each canal.

Along the canal there are 4 level crossings or barrages, at Bong, Suketar No. I, Suketar No. II, and Jhaba where further regulation of supply takes place. At these sites the torrents, which cross the canal at bed level, rise rapidly in flood after every shower of rain, often in less than half an hour. The rules,

a copy of which will be found at Appendix E (2), specify the permanent regulating staff to be engaged and detail the duties of each individual.

The next important regulating point is at the head of the Gujrat Branch, where a division of supply is made in the main canal. For this site also rules have been drawn up on the usual lines for ordinary and emergent conditions.

Finally all down the canal and on the Gujrat Branch where distributaries take off further regulation of supply occurs.

UPPER CHENAB CANAL.

The regulation of the supply at Merala at the head of this canal includes a division of the supply between the Upper and Lower Chenab Canals similar to that at Mangla at the head of the Upper Jhelum Canal. Then there are the usual complications arising out of the great variations and often rapid changes in the flow conditions of the river.

The main considerations governing the regulation are :—

(1) To meet the indents for supply and divide the water correctly between the two canals.

(2) To secure the safety of the works.

(3) To keep silt from entering the canal.

(4) To prevent the formation of heavy shoals above the weir.

(5) To direct the deep stream along the canal regulator face so that the winter supply may be suitably located.

A reprint of the regulation rules at Merala will be found at Appendix F (1). According to them it is laid down that during the flood season an Engineer Officer, the Sub-Divisional Officer, and in his absence the Executive Engineer, must be present at Merala and manage the regulation of the supply. The other rules specify the regulating staff to be engaged; the duties of each individual and the orders regarding the upkeep of a log book and diaries.

All the way down the canal rules for regulation of supply are laid down, similar to those at the headworks, but differing only in degree. There are however sometimes rapid changes due to cessation of demand arising from rainfall over a large area. On the Upper Chenab Canal, which supplies water to the Lower Bari Doab Canal, all the way to Multan, the changes in

CHAP. VIII. — Water regulation and distribution.

demand are liable to be considerable during the monsoon and winter rains. The water travels down the canal at something like 50 miles per day. It takes 2 days to get from Merala to Balloki at the head of the Lower Bari Doab Canal; and 3 days more to get to Multan. Alterations in volume of supply effected at Merala take effect at Balloki or further downstream only after the lapse of 2 or 3 days. As typical of the requirements in this respect on a canal where the supply is under control a reprint of the rules applicable to the site at mile 27 will be found at Appendix F (2).

LOWER BARI DOAB CANAL.

The nature of the works at Balloki at the head of this canal is such that very complete control of the river is obtained by means of a barrage, with large sluice openings at bed level built across the river. As Balloki is distant about 150 miles from the foot of the Himalayas, floods due to rainfall in the hills lose much of their intensity before reaching Balloki, and timely warnings are obtained of the approach of floods in the river. These conditions make regulation a trifle easier.

The main considerations governing the regulation at Balloki are :—

(1) To keep silt out of the canal.

(2) To maintain an open and as far as possible even channel along the face of the barrage between the Upper Chenab Canal inlet and the Lower Bari Doab Canal Regulator.

(3) To prevent scour in close proximity to the work.

(4) To avoid encroaching on the river supplies to which the Sidhnai Canal lower down the river is entitled.

The rules legislate for these purposes under ordinary and special circumstances. A copy of the rules and regulations will be found at Appendix G. As elsewhere the regulations lay down the strength of the regulating establishment to be maintained and define the duties of each individual from the officer in direct charge to the gauge readers. There are orders for the proper upkeep of a log book and diaries for recording the events as they occur. A constant watch on the regime of the river bed in the vicinity of the works is maintained by regular periodic probings and soundings.

As on the other canals subsidiary regulation is carried out all down the main canal at points where the distributaries take off.

(*ii*) Distribution.

Water regulation and distribution

The distribution of the supply depends on the quantity available and the nature and extent of the demand. The problem of distribution on the Triple Canal System is a complex one. During the winter or rabi season the demand is usually in excess of the available supply and the equitable division of the water to the two older colony canals and the three new canals presents many complications and calls for frequent adjustments in the water account to be maintained. The principles on which and the rules whereby the distribution is to take place will be found at Appendix H. Both the Lower Chenab and the Lower Jhelum Canals have in the past irrigated areas in excess of those anticipated in forecasts of their Project Reports. It has been arranged to allow these two canals a first call on the water supply to an extent sufficient to enable them to irrigate the areas forecast in their Project Reports; and to pool the balance of the available supply for rateable distribution between these two old canals and the Triple Canal System.

The Superintending Engineers of the various canals arrange for the distribution of water supply to the canal system for which each is responsible. The river supplies begin to increase in the spring and go on increasing to a maximum in June or July and then subside again gradually to a minimum in mid-winter. There are floods during the monsoon and freshets in the winter which occur irregularly. The demand for water is usually keenest from August to December, for the maturing of the kharif crop and the sowing of the rabi crop. It is usually slack in April and May and is subject to violent and sudden fluctuations due to rainfall. During the kharif season when the supply is usually ample, the difficulties of distribution are not great so long as the canal system is not hampered by the deposits of silt. But during the rabi season when the demand is usually strong and the supply short, the distribution of the available supply calls for great care. It has been found by experience that, when the available water supply is not sufficient to enable all the canals interested in that supply to flow full simultaneously, the most efficient and economical method of distribution is to give a full supply to as many of the canals as the water will suffice for, and the balance to one of the others, for a short period of time such as 10 days; and thereafter to give each canal its full supply for that period of time, on a regular rotational system. This is the system on which the five perennial canals interested in the flow of the rivers Jhelum, Chenab and Ravi are worked, whenever the supply of these rivers is less on the aggregate than the demand upon them. It is preferable to work them

in this fashion than to allow each canal to be in flow continuously with its calculated fractional share of full supply.

The telegraph system is a great help to the canal engineer in his control of the distribution of supply, accidental interruptions of supply through breaches of embankments, damages to works, etc., etc.

The Executive Engineer and the Sub-Divisional Officer record daily in gauge registers the gauge reading of the winter supply in every main and branch canal, and every distributary within their charge; and by means of periodical measurements of the discharge of each channel are able to tell what volume of flow of water is represented by each gauge reading.

The distribution of supply to the various parts of each canal system is reported regularly in the Weekly Weather Report which is posted every Saturday by each Executive Engineer to his Superintending Engineer and to the Chief Engineer direct. The report supplies the latest information regarding the state of weather, and condition of crops; the state of demand for water, the state of supply; the names of crops for which water is in demand; particulars of floods in rivers and cross drainage works; the daily rainfall at selected stations; the volumes demanded on indent, and the quantities supplied in the main channels with remarks regarding any circumstances likely to influence the supply or the crops or explaining any unusual condition such as insufficiency of supply, the appearance of locusts or other pests, hail-storms, etc. Once a month also the area booked by the canal Patwari as having been irrigated is reported.

CHAPTER IX.—Assessment.

The assessment of water rates on the area irrigated from the canal is made through the agency of the Canal Revenue officials working under the orders of the Executive Engineer. The assessment is made twice a year, once for each harvest. The revenue is subsequently collected by the Deputy Commissioner of the District served.

During the currency of each crop, from the time of first waterings onwards a register is maintained by the Canal Department in which is recorded the number of each field which has been irrigated with canal water. During the same period all questions regarding doubtful cases of irrigation, illicit irrigation, waste of water, etc., are enquired into and settled. About the time when the crops are coming to maturity all the fields are finally inspected, measurements of areas of fields are made whenever necessary, description of crop that has come to maturity is recorded and where crops have failed the fact is recorded. Demand slips are prepared and distributed to the cultivators setting forth the area of each field irrigated and the sum payable for water rates thereon. If the cultivator raises objections to the demand, the Canal Department investigates the same before the crops are cut and removed. If the investigation shows that the objection is valid the revenue demand is remitted, the cultivator informed in writing and the assessment papers corrected before being sent to the Deputy Commissioner for realization. Finally the cultivator pays for the water about the time when his crops are harvested and when therefore he has the wherewithal to pay.

Canal water rates are rates per acre of crop irrigated and vary with the description of crop irrigated. At Appendix I will be found the schedules of water rates sanctioned for the three canals. The rates are determined in the first instance by the Financial Commissioner and the Chief Engineer for Irrigation in consultation; and subsequently receive the sanction of Government.

At Appendix J will be found a numerical list of the staff engaged in assessing the canal revenue on the three canals. The gross commanded area is 6,246 square miles, and the annual irrigation it is estimated will be about 1,250,000 acres for the year to which the establishment figures refer.

The number of Patwaris engaged will depend on the final average irrigated area. On the average one Patwari is engaged for a gross commanded area of 10 square miles or for 4,000 acres

CHAP. IX. — Assessment.

of annual irrigation, when the land has been divided off into rectangles or squares; one zilladar supervises the work of 10 Patwaris; and one Assistant Engineer controls the operations of 2 Zilladars. The Canal Deputy Collector is the Executive Engineer's Revenue Assistant.

The duties of the various revenue officials and the manner in which the assessment is carried out are described in the Canal Revenue Manual.

The lambardar or headman of each village or portion of a village is allowed a remuneration of 3 per cent. on the amount of revenue collected by him from his fellow villagers which he pays into the State Treasury in return for which he is required to assist the canal officials in the preparation of the initial records, final measurements and other matters and to collect and pay into the treasury all canal dues. He is not a servant of the State, but he is mainly engaged to assist in the assessment by preventing mistakes as to names of owners, tenants or cultivators of the fields; and by generally acting as a medium of intercourse with the village community.

The Canal Patwari is placed in charge of a circle consisting of a definite group of villages. From the commencement of irrigation in every harvest he goes his rounds from field to field making in ink the initial record at the time the water is taken. Later on as soon as the period in the crop arrives when little or no new irrigation is expected he carries out the final check and final measurements, prepares the demand slip, stating the area measured and the amount payable, and makes it over to the cultivator to enable the latter to raise objection if he be so minded. Finally the Patwari proceeds to headquarters to complete the demand statement for each village and help in getting ready the statistical statements required for a critical examination of the work done and the results obtained. The Patwari is remunerated partly by a fixed salary of Rs. 10 per mensem and partly by a bonus varying according to the quality of the work done by him during the half year.

Zilladars are employed mainly to check and supervise the work done by the Patwaris from the making of initial record of irrigation to the final field measurements, demand slips and demand statements. They investigate all cases reported of unauthorised irrigation, waste of water, doubtful irrigation and objections to assessments. They also investigate all cases reported of crops which are alleged to have failed and recommend whole or partial remission of revenue on crops

which they find have failed. Where there is a total failure of a crop, or where its value is less than 4 annas in the rupee, complete remission is allowed; where the value of outturn is estimated to be between 4 and 8 annas half the water rate is remitted; and where the value is 8 annas or over, full assessments are made. The Zilladar should have a complete knowledge of every detail of his charge, of the nature and extent of the demand, of the available supply passing down the channels under his care, and the manner of its distribution; of the size and positions of the outlets and their discharges, of the condition of the water-courses and distribution of the rainfall, and of the state of the crops from the sowing of the seed to maturing and harvesting. He must command the respect of and have influence with the cultivators so that they seek his advice in all matters of internal distribution from their watercourses and in disputes regarding the irrigation. He may be called upon occasionally to collect the zamindars to clear their water-courses or Government channels or to close breaches.

The Deputy Collector is the Revenue Assistant to the Divisional Canal Officer and supervises generally the Divisional vernacular office work. He checks the work of the Patwari and Zilladar in the field as well as in the office.

The Deputy Collector is invested with magisterial powers under the Canal Act VIII of 1873 to try such cases as may be entrusted to him by the Divisional Canal Officer; and in practice he does most of the magisterial work of the Division.

The Sub-Divisional Officer has charge of a definite portion of the canal system, and controls it generally as an Assistant to the Executive Engineer or Divisional Officer. He is concerned more specially with engineering construction and repairs than with revenue assessment, but it is an important part of his duties to check the work of the Patwaris and Zilladars within his charge; and his engineering operations are mainly directed towards ensuring the correctest distribution of the water-supply and the improvement of the efficiency of the canal system as an irrigating machine.

The Sub-Divisional Officer usually has magisterial powers under the Canal Act and for the trial of officers against Canal law.

The Divisional Canal Officer is the Chief Executive Engineer in charge of a section of a canal system, termed a division and is responsible for its management, under the general supervision of the Superintending Engineer. He controls the whole

CHAP. IX. — Assessment.

of the engineering work as well as the whole of the revenue assessment of the area within his charge. He usually has the powers of a Magistrate under the Canal Act for the trial of offences legislated for in that Act.

Executive Engineers and their Assistants including the Deputy Collector are invested with magisterial powers for the disposal of law suits or prosecutions filed under the Canal Act. Appeals from the judgments of the Canal Magistrates lie to the Collector of the District, who is in a position to control the action of the lower courts. Canal Engineers are as a rule too fully occupied with engineering and revenue work to devote more than a small portion of their time to magisterial work; and the bulk of this work falls on the Deputy Collectors. The nature of law suits and prosecutions filed under the Canal Act is such that it is above all things essential that they should be disposed of promptly by a Magistrate holding his court in the vicinity of the site where the causes of action have arisen, and whilst the evidence (usually of the misapplication of water, or damage to canal works) is fresh and open to inspection by the Court.

The table below gives an abstract of the number and nature of cases tried by Canal Magistrates during the year 1917 on the Triple Canal System :—

Items.	Canal.		
	Upper Jhelum.	Upper Chenab.	Lower Bari Doab.
No. of Canal Magistrates invested with powers.	12	2	13
Cases instituted by Cultivators—			
(a) for taking water out of turn ...	29	26	65
(b) for other reasons	1	6	3
Cases instituted by the State—			
(a) breach of tatil	...	1	2
(b) Cattle trespass	36	12	12
(c) other causes	25	24	22
Total number of cases tried ...	91	69	104

CHAPTER X.—Minor Operations.

CANAL ARBORICULTURE.

The cultivation of Avenues and Plantations along the banks of Canals is a natural consequence of the facilities for irrigating the same, that is afforded by the water-supply. The table below gives particulars of the progress of arboriculture on the Triple Canal System down to the end of the year 1916-17 :—

Items.	Canal.		
	Upper Jhelum.	Upper Chenab.	Lower Bari Doab.
Area under nurseries (in acres) ...	0·43	0·44	2·69
Area taken up for plantations (in acres) ...	1,206·5	934·3	1,435·0
Area stocked with growing trees (in acres)	1,093·5	555·2	1,238·3
Length of canal (in miles) suitable for the formation of avenues.	125·5	660·5	813·5
Length of established avenues (miles) ...	33·0	147·0	336·0

All irrigation water-rate dues are collected on behalf of the Canal Department by the Collectors of the Districts concerned. There are, however, collections of miscellaneous dues on account of water used in other ways than in irrigation. These the Irrigation Department collects for itself in cash or by credit transfer from other Government Departments. Small sums due for water used in making bricks, constructing concrete or masonry, etc., are collected by the local Canal Zilladar who keeps a Cash Receipts Accounts, paying the sums collected, at suitable intervals, into the Sub-Divisional Cash Chest. Larger sums, due for grazing leases, mill rents and water sold in bulk for filling tanks, are received by the Sub-Divisional Officer. Other items of Miscellaneous Receipts are received by book transfer by the Executive Engineer and are shown in the accounts of the Division. The Accountant-General, after audit, registers the miscellaneous receipts from all sources and annually prepares a statement in which the entries are classified.

The blue book of statistics of irrigation, water distribution and working of distributaries, published year by year, contains a number of statements repeated for each canal separately. A list of these statements will be found at Appendix K and in the remarks following, some of the uses to which the figures can be put will be described.

CHAP. X.

Minor Operations.

The statement of supply entering the canal at its head, of the quantity escaped back into the river, of transit losses due to absorption, percolation and evaporation combined and of the actual discharge utilized, exhibits the efficiency of the main canal and its branches. The information contained in the table is obtained from the Engineer's gauge registers. Gauge Readers record and report the depth of supply running in the various channels. In order to convert these lineal gaugings into discharges it is necessary to have accurate discharge tables or discharge diagrams. As unfortunately the relation between the gaugings and discharge is not constant, it is necessary to measure the discharge of channels systematically and periodically at suitable sites near the heads of the main canal, of its branches, and of all distributaries. The results of the measurements are used to correct or keep up to date the discharge table for each site.

CHAPTER XI.—Statistical.

Statistical statements are prepared half yearly in which the working of the distributaries is reviewed, the average discharge passed into each distributary is therein compared with the authorised supply and the area actually irrigated in the year. From these are deduced the "Delta" or quotient of water volume consumed divided by the area irrigated, and with the "duty" which is the quotient of the area irrigated in acres divided by the average volume of flow in cusecs throughout the period taken into account. The cost of maintenance per mile is shown and also the percentage ratio borne by the irrigated area of the year to the culturable commanded area. From the figures in this table the Irrigation Engineer is able to deduce the relative efficiency of the various channels in his charge.

CHAPTER XII.—Other Government Activities.

In more or less settled tracts such as those through which the Upper Jhelum and Upper Chenab Canals have been taken there is quite a lot of work thrown on to other departments as a result of the introduction of canal irrigation. The District Officer or Collector, finds himself acquiring land for the canal and assessing compensation under the Land Acquisition Act. During construction he is concerned with the positions at which bridge crossings are to be constructed for the convenience of the traffic across the canal. Later on he has to watch the distribution of the benefits of irrigation. The large increase in population, due to an inflow of labour-gangs, gives the Police additional work, and often new problems to solve in criminal investigations. The Registrars of births and deaths and the Registrars of deeds and contracts have more to do. The Civil Surgeon of the District is required to inspect, supervise and advise on the canal dispensaries, and medical staff introduced for the purpose of attending to the needs of the canal establishment and work people. The Post and Telegraph Departments have their work added to, and there is a considerable increase in the goods and passenger traffic of the railways serving the tract, both during construction and subsequently. More cases come before the Civil and Criminal Courts. And the Treasuries and Sub-Treasuries of the District have to deal with the huge sums expended on construction and the half-yearly collections of revenue.

Montgomery possesses a Municipal Committee, whose President is the Deputy Commissioner, and this officer also administers the notified area of Okara. Both these bodies were in existence before the canal was constructed. The scope of their activities has widened. The notified area committee of Chichawatni was constituted on the 25th of October 1915; and consists of the Colonization Officer, the Extra Assistant Colonization Officer, the Tehsildar *abadi* of Chichawatni, and the Zaildar of Chichawatni. Its chief concern is the development of the new township on the Chichawatni Road which has not yet progressed far.

There are already a few schools in the Lower Bari Doab and their number is steadily being increased. The Educational Establishment is in the charge of the Deputy Commissioner of Montgomery, who has recently prepared a five-year programme to work to. Although there has not as yet been any marked influx of pupils generally, in a few places the schools are prospering.

CHAP. XII.

Other Government Activities.

There is an old established hospital at Montgomery; but for the rest of the district there are at present only a few sub-dispensaries. There are some dispensaries worked by the Irrigation Department and the District Board jointly. In the matter of markets those at Montgomery and Okara are old, and growing. They are under the control of the Deputy Commissioner of Montgomery. Others at Chichawatni, Mian Channu, Khanewal and Jahanian, all situated along the North-Western Railway, are under the control of the Colonization Officer. Of these latter, that at Mian Channu has made most progress to date; and that at Jahanian least. At Mian Channu 115 residential sites in the town, 124 sites for shops in the mandi and in the town, one site for a flour mill and three sites for factories have been sold. Some of the prices realized were high, *e.g.*, Rs. 2,700 for a shop site in the *mandi*, and Rs. 4,100 for a combined shop and residential site in the town. Although Khanewal is the headquarters of the Sub-Divisional Officer, and now boasts of a Tehsil, a Thana and a Munsif's Court, progress has been slower. Government has just disposed of a large site for a factory here. Chichawatni Road Market has also begun to expand under the influence of the favourable prices received for good clean cotton of the variety called Punjab 4-F. and all the shop sites in the *mandi* have been sold. The demand for residential sites is not, however, so keen at present. The removal of the Kasur-Lodhran Railway has caused the diversion of a certain amount of trade from the Sutlej Valley towards Chichawatni Road and this tendency may become more pronounced in the future. Jahanian is not likely to grow rapidly. It is situated near the extreme south-western limit of the irrigated tract; does not command an extensive "hinter land;" and it has not the compensating advantage enjoyed by Khanewal of being a large railway junction and centre for transhipment.

Industries other than those directly connected with agriculture hardly exist yet, for cotton-ginning and *bhusa* pressing are in reality but adjuncts to agriculture.

Situated near Montgomery is the Agriculture Department Seed Farm, which has been at work for about one year; but there are at present no special developments to record. An Agricultural Assistant is in charge who in addition tours in the colony and superintends the distribution of select seeds (chiefly of Punjab 4-F-cotton and Punjab II-wheat) for which there is now a wide demand. Special attention is to be devoted to experiments to determine whether hard barren soil of the kind called *bara* can be made to yield to the influence of canal irrigation.

APPENDIX A.

Capital cost of the Triple Canals on 31st March 1917 when the Capital Account was closed.

Main and sub-heads.	Amounts by sub-heads. Upper Jhelum Canal.	Upper Chenab Canal.	Lower Bari Doab Canal.	Total.
	Rs.	Rs.	Rs.	Rs.
A.—Direct charges.				
I.—Works—				
(1) Headworks	2,60,656	71,60,249	52,17,077	1,26,37,982
(2) Main Canal and Branches	3,10,63,435	1,47,85,054	65,38,801	5,23,87,290
(3) Distributaries ...	16,88,449	44,18,148	42,72,001	1,03,78,598(a)
(4) Drainage and Protective Works.	7,085	11,95,741	58,987	13,61,813
Total I—Works ...	3,30,19,625	2,75,59,192	1,60,86,866	7,66,65,683
II.—Establishment.	47,21,948	44,87,333	30,07,003	1,22,16,284
III.—Tools and Plant	45,91,767	21,90,148	19,34,767	87,16,682
IV.—Suspense	10,35,201	6,84,829	9,02,006	26,22,036
Totals ...	4,33,68,541	3,49,21,502	2,19,30,642	10,02,20,685
—*Less* Receipts on Capital Account.	—3,56,957	—5,59,865	—5,10,369	—14,27,191
Total.—Direct charges ...	4,30,11,584	3,43,61,637	2,14,20,273	9,87,93,494
B.—Indirect charges.				
3 Capitalization of abatement of Land Revenue.	1,82,300	3,59,650	43,950	5,85,900
(25) Leave and Pension allowances...	6,56,063	6,20,897	4,10,040	16,87,000
Total Indirect charges ...	8,38,363	9,80,547	4,53,990	22,72,900
Total—Direct and Indirect ...	4,38,49,947	3,53,42,184	2,18,74,263	10,10,66,394
Accumulated simple interest ...	85,23,443	83,09,216	39,00,649	2,07,33,308

(a) Includes on account of cost of watercourse recoverable from settlers—

Upper Jhelum Canal	Rs. 1,56,793
Upper Chenab Canal	„ 1,04,3 8
Lower Bari Doab Canal	„ 11,47,571
Total ...	Rs. 14,08,692

APPENDIX B (1).

Upper Jhelum Canal Circle.

List of Superintending Engineers who have held charge.

Name of Superintending Engineers.	Period of incumbency.	
	From	To
Mr. J. T. Farrant	14th March 1905	16th September 1906
Mr. T. R. J. Ward, C.I.E.	17th September 1906	29th October 1906
Mr. J. T. Farrant	30th October 1906	7th December 1907
Mr. R. Egerton Purves	8th December 1907	26th February 1908
Mr. F. E. Gwyther	27th February 1908	28th March 1908
Mr. R. Egerton Purves	29th March 1908	1st October 1910
Mr. A. J. Wadley	2nd October 1910	17th October 1910
Mr. R. Egerton Purves	18th October 1910	18th March 1911
Mr. F. W. Carne	19th March 1911	7th April 1911
Mr. A. J. Wadley	8th April 1911	17th October 1911
Mr. R. Egerton Purves	18th October 1911	25th April 1913
Mr. R. P. Hadow	26th April 1913	28th April 1913
Mr. J. N. Taylor	29th April 1913	27th March 1916
Mr. H. W. M. Ives	28th March 1916	1[illegible]th Febr
Mr. J. W. Gillmon	16th February 1918	...

APPENDIX B (2).

Upper Chenab Canal Circle.

Name of Superintending Engineers.	Period of incumbency.	
	From	To
Mr. W. E. T. Bennett	23rd February 1905	1st January 1908
Mr. F. W. Schönemann (Woods)	2nd January 1908	17th January 1908
Mr. W. E. T. Bennett	18th January 1908	9th May 1908
Mr. H. W. M. Ives	10th May 1908	11th May 1908
Mr. T. R. J. Ward, C.I.E.	12th May 1908	11th November 1908
Mr. W. E. T. Bennett	12th November 1908	20th April 1909
Mr. H. W. M. Ives	21st April 1909	25th October 1909
Mr. W. E. T. Bennett	26th October 1909	20th April 1910
Mr. H. W. M. Ives	21st April 1910	4th April 1911
Mr. F. W. Holmes	5th April 1911	28th April 1911
Mr. H. W. M. Ives	29th April 1911	16th May 1912
Mr. F. C. Rose	16th May 1912	10th June 1912
Mr. C. J. Floyd	11th June 1912	20th January 1914
Mr. H. W. M. Ives	21st January 1914	20th March 1915
Mr. F. C. Rose	21st March 1915	10th June 1915
Mr. H. W. M. Ives	11th June 1915	25th March 1916
Mr. N. White	26th March 1916	...

APPENDIX B (3).

Lower Bari Doab Canal Circle.

Name of Superintending Engineers.	Period of incumbency.	
	From	To
Mr. J. G. Davis	11th October 1906	2nd June 1908
Mr. F. W. Schönemann (Woods)	3rd June 1908	11th July 1908
Mr. F. C. Rose	12th July 1908	15th July 1909
Mr. G. C. Laurie	16th July 1909	20th November 1909
Mr. F. C. Rose	21st November 1909	19th December 1909
Mr. J. C. Davis	20th December 1909	14th January 1910
Mr. F. C. Rose	15th January 1910	28th April 1911
Mr. W. F. Holms	29th April 1911	17th October 1911
Mr. F. C. Rose	18th October 1911	9th June 1914.
Mr. W. P. Sangster	10th June 1914	1st October 1914
Mr. Rose	2nd October 1914	15th December 1914
Mr. Sangster	16th December 1914	18th April 1916
Mr. H. E. Pellereau	19th April 1916	13th November 1916
Mr. R. Cannell	14th November 1916	To date.

APPENDIX C.

Numerical strength of superior staff of Triple Canals.

Name of Canal.	Name of Division.	Numbers of Executive Engineers.	Numbers of Sub-Divisional Officers.
Upper Jhelum ...	Jhelum	1	4
	Phalia	1	3
	Gujrat	1	3
	Total ...	3	10
Upper Chenab ...	Merala	1	2
	Gujranwala	1	3
	Sheikhupura ...	1	2
	Raya	1	2
	Total ...	4	9
Lower Bari Doab ...	Balloki	1	4
	Okara	1	3
	Montgomery ...	1	3
	Khanewal	1	3
	Total ...	4	13
GRAND TOTAL TRIPLE CANAL SYSTEM.	...	11	32

APPENDIX D.

Numerical strength of works subordinates, office staff, and auxiliary services, Triple Canals.

Name of Canal.	Division.	Works Staff.				Office Staff.		Regulating Staff.		Telegraph	Medical.
		Upper Subordinates.	Lower Subordinates and Surveyors.	Mistries and artificers.	Store-keepers.	Accountants and Clerks.	Draughtsmen and tracers.	Gauge readers.	Jamadars and Beldars.	Telegraph operators.	Sub-Assistant Surgeons.
Upper Jhelum ...	Circle office ...	...	...	...	...	10	1	...	...	1	...
	Jhelum ...	5	10	23	...	15	4	17	102	17	3
	Phalia ...	4	11	10	1	12	5	32	...	6	2
	Gujrat ...	5	9	2	...	11	6	16	...	11	2
	Total ...	14	30	35	1	48	16	65	102	35	7
Upper Chenab ...	Circle office ...	...	...	...	...	10	2	...	...	2	...
	Merala ...	2	7	8	1	10	4	20	28	10	1
	Gujranwala ...	3	10	7	1	11	7	32	...	11	2
	Sheikhupura ...	2	10	1	1	10	5	29	...	12	2
	Raya ...	3	7	3	...	10	6	36	...	9	3
	Total ...	10	34	19	3	51	24	117	28	44	8
Lower Bari Doab	Circle office ...	...	1	...	...	9	5	...	...	1	...
	Balloki ...	6	7	7	1	13	8	18	31	11	2
	Okara ...	3	12	3	...	12	7	33	21	9	3
	Montgomery ...	2	11	5	1	13	10	38	4	14	1
	Khanewal ...	5	11	4	...	12	7	18	...	13	3
	Total ...	16	42	19	2	59	37	107	56	48	9
Triple Canals ...	Grand Total	40	106	73	6	158	77	289	186	127	24

APPENDIX E (1).

Upper Jhelum Canal.

General Rules for Regulating Supply, 1920.

1. All indents to be by gauge and equivalent cusecs.

2. The Phalia and Gujrat Divisions will indent on Executive Engineer, Jhelum, for their supplies at Khokhra.

3. Executive Engineer, Phalia Division, will, when giving his indent, inform Executive Engineer, Jhelum Division, what gauge above his indent he can safely run in the Gujrat Branch in the event of an accident happening to the Main Canal.

Executive Engineer, Gujrat Division, should keep Executive Engineer, Jhelum Division, informed of the highest gauge he can take below Khokhra in case of an accident in the Gujrat Branch.

4. In cases of emergency, such as serious breaches, urgent wires may be despatched by Sectional Subordinates, Mates of patrol gangs, and Zilladars, to all concerned.

If a branch occurs in the Gujrat Branch, the Jamadar, Khokhra, may without waiting for orders, raise supply in the Main Canal below Khokhra at the rate of one foot per hour, on Khokhra downstream gauge, up to the limiting gauge given as per paragraph 3 above. Executive Engineer, Jhelum Division, must be informed at once and he will take measures to reduce supply in canal by amount equivalent to indent for Gujrat Branch.

In the event of a breach in the canal above Khokhra, pending orders from Executive Engineer, Jhelum, the Jamadars Jaggu, Rehmanpur and Jatli will immediately close the canal and escape all water, and Sub-Divisional Officer, Headworks, will arrange to close the canal.

In case of a breach in the canal below Khokhra, the Jamadar at Khokhra should at once raise the Gujrat Branch to its limiting gauge as intimated by Executive Engineer, Phalia Division (*vide* paragraph (3)) and Jamadars, Jaggu, Rehmanpur and Jatli should at once close canal and escape water, pending orders from Executive Engineer, Jhelum Division.

5. On opening the canal after a closure the gauge at R. D. 5,000 may be raised to 4.0 feet at once, thereafter at the rate of 0.5 foot per hour, up to 7.0 feet, then at the rate of 0.2 foot per hour, up to indent.

6. Time of opening the canal at Mangla to be wired by Sub-Divisional Officer, Headwork, to all Executive Engineers and Sub-Divisional Offficers on the Upper Jhelum Canal.

7. In the event of the fluctuations in the supply, squrplus water at Khokhra will be passed down the Main Canal, and in the event of a deficiency, the supply in the Gujrat Branch will be kept steady and the supply in the Main Canal will be reduced by the amount of the deficiency.

8. A programme of Rotational Turns will be prepared by Superintending Engineer, which will come into force in the event of there being a deficiency of water in the river.

9. All Sub-Divisional Officers in the Phalia Division should comply with the indent of the Sub-Division below as soon as possible.

10. Sub-Divisional Officers must confirm all telegrams despatched by their subordinates immediately they have realized the state of affairs.

11. All Jamadars should be supplied with boards, hung up in their quarters, showing the ordinary maximum gauges for the canal. Jamadar Khokhra to also show on his board the limiting gauges for the Gujrat Branch and the Main Canal below Khakhra, as supplied from time to time by the Executive Engineers, Phalia and Gujrat Divisions (*vide* paragraph 3).

APPENDIX E (2).

Draft Rules for the working of the Mangla Regulator.

1. *Officer in Charge.*—The management and maintenance of the Regulator are under the immediate charge of the Sub-Divisional Officer, Headworks, whose head-quarters are at Mangla.

2. *Duties.*—The Sub-Divisional Officer must not be absent from Mangla at night during the monsoon (from 1st June to 10th October) unless the Executive Engineer is at Mangla.

Sub-Divisional Officer's Duties.

(*a*) To comply promptly and accurately with all indents.

(*b*) When the river falls below the combined requirements of the Upper Jhelum and Lower Jhelum Canals, to wire and inform Superintending Engineer, Upper Jhelum Canal, sending copy to Chief Engineer and Superintending Engineer, Lower Jhelum Canal, Upper Chenab Canal, Lower Chenab Canal, and Lower Bari Doab Canal, and Executive Engineers, 1st Division, Lower Jhelum Canal, Rasul, Executive Engineers, Merala, Khanki and Balloki, and at once to start rotational working in accordance with the regulations which will have been issued to him towards the end of the monsoon.

(*c*) To issue written orders to the Jamadar regarding changes in supply with copies to all concerned.

(*d*) To visit the work at night, and see that the staff are on duty and everything in order and to record such visits in the log book.

(*e*) Personally, to supervise preparations for floods, and to see that the staff carry out the duties assigned to them.

(*f*) To see that all gates, gearing, etc., are always in proper working order.

(*g*) To see that when closigg against a flood the turbine supply is promptly attended to, and the turbine not allowed to race.

3. *Establishment.*—The establishment shall be as follows:—

1 Jamadar.
1 Naib-Jamadar.
12 Beldars.

6 Boatmen.

3 Gauge Readers.

1 Bhishti.

1 Sweeper.

2 Drivers for turbine house.

1 Mistri for Electric Plant on Head.

2 Telephone Attendants.

1 Peon.

The Sub-Divisional Officer will be held responsible for the efficiency of the staff, and should see that the beldars are all strong, able-bodied men and good swimmers.

The strength of the establishment should not be reduced without the Executive Engineer's permission.

4. A log book will be kept in which the Jamadar must record the hour and date of all changes in regulation and working of the gates, and any special occurrence such as the removal of timber from the gate openings, etc. All important orders will be entered in this also, and the Sub-Divisional Officer will see that the Jamadar and Naib-Jamadar understand them.

Orders will be given by the Sub-Divisional Officer to the Jamadar and Naib-Jamadar direct. The subordinate incharge will record them in English in the log book. The log book will be signed weekly by the Sub-Divisional Officer.

5. *The Jamadar's Duties.*—(*a*) To report promptly in writing to the Sub-Divisional Officer, any damage or defect he is unable to rectify, copying the report into log book, noting the time and date of its despatch.

(*b*) To carry out the Sub-Divisional Officer's orders regarding supply and to correct the supply promptly when it is not in accordannce with orders.

(*c*) To carry out all other regulations, and working promptly and accurately as ordered by the Sub-Divisional Officer.

(*d*) To exercise, under the Sub-Divisional Officer's orders immediate control over the boatmen and Beldars, and to drill them to their duties. To report men who become sick or inefficient, and to see that no one is absent without leave granted by the Sub-Divisional Officer.

He should call the muster roll at odd times and note absentees in the log book.

(*e*) To see that all gates, gearings, etc., are kept clean and to report all breakages promptly to the Sub-Divisional Officer.

(*f*) To see that no one loiters about the work, especially in the chambers underneath the roadway, and to prevent any one from attempting to work the gearing.

(*g*) To see all public traffic is carried on by the roadway at R. L. 915 level, and that the gallery at R. L. 893 is only used by the canal employees.

(*h*) To arrange the working of the Sentry Programme and to inform the Sub-Divisional Officer of any changes made in it.

(*i*) To see that the Regulator is properly lit up at night and to inform the Sub-Divisional Officer of any failure in the lighting arrangements.

6. *The Naib-Jamadar's Duties.*—The Naib-Jamadar will carry out the same duties as the Jamadar when the latter is off duty. The hours of duty for each to be fixed by the Sub-Divisional Officer and approved by the Executive Engineer. But when a flood comes down he will summon the Jamadar, who will take charge, and will depute the Naib-Jamadar to any special work which he may select for him.

7. *Beldar's Duties.*—(*a*) To petrol the work and attend to the gauges.

(*b*) To keep the Regulator and gearing clean.

(*c*) To be on watch in pairs for spell of three hours under the Jamadar's orders.

(*d*) To watch the weather and river and report all changes to the Jamadar, or the Naib-Jamadar.

(*e*) To wear their uniform when on duty.

(*f*) When off duty, and not resting before going on duty to keep the gearing, etc., cleaned and oiled and to work the gearing daily according to the orders of the Jamadar and the subordinate in charge of the Regulator.

8. *Boatmen's Duties.*—(*a*) To keep their boats clean and in order, ready for use.

(*b*) To be always ready to man a boat if required.

(*c*) To sleep at night in the regulating quarters.

Regulation Rules.

9. (1) The canal supply will be all admitted through the same series of gates: should the upper series be insufficient to pass it. They shall be closed and the next lower series opened. Different series shall not be in use at the same time except when the daily testing of the lower two tiers of gates is in progress.

(2) The openings shall be equal in the series of gates at work as far as possible; but small variations in supply may be met by raising or lowering one set of four gates which will generally be the central one.

(3) The lower two tiers of gates will not be kept closed throughout the Hot Weather. The eight gates on one set of gearing will be lifted every day so that the gates may not get jammed from disuse. In this way the entire lower tiers or gates will have been worked every five days.

The testing will be done as follows:—

The other upper gates will first be slightly raised and the upper gates of the series under test closed. This will prevent the canal supply from being lowered. Then the middle gates of the bay under test will be lifted sufficiently to admit the discharges which had been coming through the upper gates, and then closed. The lower gates will then be

raised to similar extent and closed. The testing of the set will be noted in the log book, and the upper gates again opened and Regulation carried on as before.

The Sub-Divisional Officer should be present at this testing, and should be thorougly acquainted with its general state of progress and with any difficulties encountered.

During the monsoon immediate steps should be taken to be in readiness to close the canal when the gauge in the Force bay reaches R. L. 885 and the river seems to be rising. The actual time of closing down from the time this gauge is reached must be at the discretion of Sub-Divisional Officer, who should keep himself in constant touch with the state of affairs at the head, but in all cases he must close down before the level of 890 is reached and not re-open till the gauge is again at 885, and on a falling river.

With a closed Regulator and a high flood, should strong springs appear downstream of the work, the gates should be opened sufficiently to give the current authorised discharge and check the action of the springs.

10. For the winter floods, it is as yet impossible to lay down Rules. It may be considered for the present that a level of 884 is likely to be the maximum reached and that therefore the Regulator might remain open.

There will be large amount of timber coming down, however, and this may lead to its being necessary to close the canal, or to draw off through the lowest series of gates, the 'draw' of which will probably not be enough to take timber in the canal.

11. Emergent closure may be made at any time by the Sub-Divisional Officer, Headworks, or the Executive Engineer: due information being sent to the Superintending Engineers concerned.

12. The floods in the Jhelum are notified from Kohala. The Poonch floods are not yet provided for. The rules regarding flood warnings to be sent to Rasul are given in this office letter No. 5693, dated 24th October 1914, to Executive Engineer, 1st Division, Lower Jhelum Canal, and are briefly:—

April 1st to September 30th.—A rise of 3 feet in 12 hours to be tellegraphed to Sub-Divisional Officer, Headworks, Lower Jhelum Canal, Rasul.

October 1st to Much 31st.—A rise of 1 foot in 12 hours to be telegraphed to Sub-Divisional Officer, Headworks, Lower Jhelum Canal, Rasul.

13. *Report of Accidents.*—The Sub-Divisional Officer on receipt of a flood warning will issue necessary orders to the Jamadar and confirm them in writing.

All serious accidents to be wired to Superintending Engineer and Chief Engineer at once and followed promptly by detailed reports.

DETAILS OF THE REGULATOR.

Bays	20 No. ...	... 12.0′ span.

Gates 60 in three tiers.

Size of upper gates	12.0′ × 8.0′
Size of middle gates	12.0′ × 6.5′
Size of lower gates	12.0′ × 6.75′
R. L. of crest	852.5
R. L. of upper surface reinforced cill ...	868.0
R. L. of canal bed downstream	847.6
R. L. of centre of invert	842.6
R. L. soffit of arches of Diaphragm wall ...	876.00
R. L. Gallery floor level	893.08
R. L. Roadway	915.00
R. L. Top of front cornice	917.00
R. L. Highest flood	912.00
R. L. D. S. Canal Wings cornice	861.00

APPENDIX E (3).

Rules for Regulation at Level Crossings on the Upper Jhelum Canal, 1913.

For the proper safeguarding of the Level Crossings the following Rules for regulation and management of floods thereat are laid down and must be strictly adhered to. **The rules.**

A copy of the Rules must be kept in each of the following places:—

(*i*) In personal charge of the Executive Engineer.

(*ii*) In personal charge of the Sub-Divisional Officer.

(*iii*) In personal charge of Sectional Subordinate.

(*iv*) In the Telegraph Office at the Level Crossing, in charge of the Signaller.

Log Books will be kept on the works. **Log Book.**

1. *Executive Engineer.*—The Executive Engineer should test the working condition of the gates and gearing and the efficiency of the staff in the months of June and December each year. **Duties of Staff.**

2. *Sub-Divisional Officer.*—The Sub-Divisional Officer will be responsible for general supervision of the work and good condition of the gates and gearing, for the appointment of the staff and the arrangement of their duties. Sub-Divisional Officer, Jatli, must never be absent from head-quarters for a night between June 1st and October 1st unless he has formally handed over the regulation to the Executive Engineer at Jatli. Executive Engineer must remain at Jatli until Sub-Divisional Officer returns. Sub-Divisional Officer, Jaggu, must not be absent from Jaggu except during the day time between 1st June and 1st October.

At least once a month during the cold weather from September to April and twice a month during the hot weather from April to September he should personally inspect all gates and gearing and satisfy himself that they are all in good working order and that the staff is efficient in the performance of its duties. He should note in the Log-Book the date of each inspection made by him with brief remarks on any points calling for attention and the orders issued thereon by him.

3. *The Sectional Subordinate*—will live in the quarters provided for him near the works. From 1st June to 10th October he must always sleep in the Beldar's quarters where a room is provided for him, and must never leave his station without the written permission of the Sub-Divisional Officer who will make proper arrangements for carrying on his duties. He will be responsible for the proper training and inspection of the staff, which will be under his immediate control, in its duties, and he should frequently muster the men to see that all are present.

He must also see that all gates and gearing are kept in good order and properly cleaned and oiled and must frequently inspect all bunds and masonry works and report promptly any damage found.

He will be immediately responsible for regulation during floods, and on receipt of a flood alarm must at once turn out on to the work and take charge until the flood subsides. He must enter up full particulars of each flood with his own hand in the Log-Book, and in the event of any damage resulting from a flood will at once report by telegram to the Sub-Divisional Officer and Executive Engineer.

4. *Signaller.*—The Signaller will be responsible for the maintenance of the Log-Book and Gauge Register in English and for presenting them to Inspecting Officer for recording notes or orders.

It will also be his duty—

(*a*) to test the electric alarm bells twice weekly and keep them in order;

(*b*) to train his peon in recognising the telegraphic single call of the station.

Whenever canal supply is reduced for a flood he will at once notify by wire the Sub-Divisional Officer, all Executive Engineers and all Signallers at regulating stations, Upper Jhelum Canal, and he will again notify them on supply being restored.

Abnormal conditions occurring.

In the event of excess supply passing into the canal due to a flood, Signaller, Jabah, will at once wire warning to the Signallers, Sub-Divisional Officers and Executive Engineers concerned at R. D. 255,000 and at R. D. 418,000 feet, Upper Jhelum Canal, informing them of the maximum gauge reached below Jabah Regulator.

5. *Jamadar.*—The Jamadar will be in charge of the regulation under the direct orders of the Sub-Divisional Officer. He will exercise immediate control over the regulating Beldars and will be responsible that all gates and gearing are kept in good working order and all parts of the Level Crossing are kept clean and tidy. He will keep a roster of duties for Beldars and Gauge Readers and see that it is worked to, himself visiting the guards at intervals to see that they are on the alert. It will be his duty to train all Beldars and to report promptly any inefficiency, illness or lapse from duty to the Sectional Subordinate.

During a flood the Jamadar will be present on the Weir over bridge and will be in charge of weir regulation. Whenever gauge Upstream of Regulator rises above what is sufficient to keep the canal gauge below Regulator up to indent, he must reduce supply by raising weir gates.

The Jamadar is also responsible that all Lamps are kept in good order and properly lit at the times prescribed.

6. *Naib-Jamadar.*—The Naib-Jamadar will act generally as Assistant to the Jamadar and must make himself thoroughly acquainted with the working of all parts of the Level Crossing so that he may be capable of acting for him during leave vacancies, &c.

The Naib-Jamadar's post during a flood is on the Regulator where, with his gang he will close gates as necessary, taking care that the canal gauge does not rise above indent.

7. *Beldars*—will work under the orders of the Jamadar or Naib-Jamadar as they may be required to do and will take turn of duty on guard to receive flood warnings and sound the alarm. Two Beldars will always be on duty.

8. *Gauge Readers*—will read and report gauges periodically as may be ordered taking turns of duty according to the roster. The man on duty will be required to patrol the work and watch gauges and to ring the alarm bell should the water rise above the level laid down.

Gauge Readers off duty must turn out on hearing a flood alarm and go to their appointed stations

9. The regulating staff will consist of— Scale of Staff.

1	Signaller	Permanent Staff.
2	Telegraph peons	
1	Jamadar	
1	Naib-Jamadar	
20	Beldars	
2	Gauge Readers	

10. Except the Signaller the whole staff will be appointed by the Sub-Divisional Officer, who must satisfy himself that the men are in all respects suitable. Newly appointed men should be dismissed if not found efficient after two months' training. Appointments of Staff.

The Jamadar should be an experienced and intelligent man, preferably one who has passed through the grades of Beldar and Naib-Jamadar. He must be able to control the men under him and to maintain a duty roster in vernacular and a Vernacular Log-Book. Must be a good swimmer.

The Naib-Jamadar must have similar qualification, but will have less experience.

Beldars must be selected for appointment with care.

They should be intelligent men of good phisique and good character, and must be strong swimmers.

Gauge Readers should be similar men, but must be able to read and write in vernacular. They should be selected from among the Beldars if possible.

11. Every man must have a definite duty and a definite station allotted to him for flood regulation so that all may know exactly where to go and what to do. The Jamadar will arrange what men are to form the various gangs and patrols which are ordered by the Sub-Divisional Officer and to test the organization, the Sub-Divisional Officer should occasionally have trial alarm drills under his personal supervision. Organisation of Staff.

The Beldars should be divided into two gangs, one of four men under Naib-Jamadar will be allotted to the Regulator, and the other of sixteen men under the Jamadar will do duty on the weir. The same men should not be kept always in the same gang, but they should be interchanged periodically two at a time so that all may be acquainted with both jobs.

Two Beldars will always be on duty day and night on the Regulator gauge to receive flood warnings and turn out the gangs. The turn of duty on guard should not exceed three hours nor should any one man be required to go on duty for more than two spells in 24 hours. The Beldars on guard duty must on no account be given any other work during their turn of duty. The Gauge Readers will also be on a duty roster such that one man is always on duty day and night, the other being ready to turn out in the event of the alarm being given.

Leave of absence.

12. No member of the regulating staff may go on leave except under the written order of the Sub-Divisional Officer, and between June 16th and September 15th and December 15th and April 30th, no member of the staff shall be allowed leave unless an efficient substitute is arranged for. At other time leave without a substitute may be granted by the Sub-Divisional Officer provided that not more than four men are absent at one time.

Quarters.

13. All members of the staff must live in the quarters provided for them and must never be absent from their quarters at night except on leave properly sanctioned.

Gearing.

14. All gearing must be kept thoroughly cleaned and oiled and must be tested between April 15th and October 1st every 15 days to ensure that it is in good working order and once in three months during the remainder of the year.

Any defect in or damage to the gearing must be at once made good or if beyond the local means of repair must be reported at once to the Sub-Divisional Officer.

Arrangements for giving warnings of floods.

15. For arousing the staff there will be an alarm gong situated just outside the guard room.

Action on receipt of a flood warning.

16. On receiving a warning the Beldar on duty will immediately arouse the Jamadar.

When an alarm is given the Jamadar will at once proceed to the guard room and having satisfied himself that the men are all aroused will proceed to the weir and take charge of the working of the gates. The Naib-Jamadar and all Beldars and Gauge Readers will proceed at once to their posts on the Weir or Regulator as the case may be.

The Signaller will at once send his peon to call out the Sub-Divisional Officer and Sectional Subordinate.

The Gauge Reader on duty will on an alarm at once note the time and stand by on the Weir, note times of opening and closing of Weir gates while the other Gauge Reader will proceed on to downstream abutment of the Weir and will note the gauge readings at interval of 10 minutes and will also note the time of reducing the canal. *When a flood occurs the supply in the canal downstream of Regulator must be reduced straightway one foot.*

Regulation on the Weir.

(*i*) On the occasion of a flood all gates should be raised together, care being taken that the Level Upstream of the Weir does not rise above

what it was before the flood occurred nor should it be reduced by more than half a foot.

(*ii*) The object to be aimed at should be to keep the water level upstream of the weir as nearly as possible at the same level as it was before the flood arrived.

(*iii*) When the flood is subsiding all gates should be lowered together keeping the upstream gauge as constant as possible.

Suketar No. 1.

17. On the occurrence of a flood the centre series of four gates should be fully opened at once followed quickly by those on either side of it as the flood rises. When the flood is subsiding the gates should be closed from the outside inwards.

General.—If any damage occurs to the protection downstream the gates opposite the place, where the damage has occurred should be lowered and closed as quickly as possible, care being taken that there is no excessive heading up upstream.

18. (*i*) Adjustment of supply in the Canal must be effected solely by means of the top gates. Cill gates being always kept up. All top gates should be immersed from one to three inches. **Regulation at the Regulator.**

(*ii*) On re-opening the canal after a flood the supply should be at once restored as follows:—

> Fifty per cent. of the indent to be made up at once, and supply kept constant at this for 12 hours. Thereafter the rise to be 0.2 feet per hour till full indent has been re-established.

(*iii*) In the event of a flood passing off quickly or rising very little the Regulator need only be sufficiently closed to prevent excess supply in the Canal, but it will be for the Sub-Divisional Officer to decide in each case whether or not the Regulator should be completely closed, regard being had to the state of the weather and probability of further floods.

(*iv*) In the absence of the Sub-Divisional Officer the Jamadar will take action obtaining confirmation of the same from the Sub-Divisional Officer by Canal Telegram.

(*i*) At Jabah Level Crossing reduction of indent should be complied with by escaping water over the Weir and increases of indent should as far as possible be complied with by reducing escapage. **Changes of supply.**

(*ii*) As soon as the effect of a change of supply is felt the Signaller will notify the regulating Signaller next downstream of the fact. **Lighting the work at night.**

Lamps for lighting the work will be attended to by the Beldars under the supervision of the Jamadar.

Between June 1st and October 10th all Lamps will be lit every evening at sunset except when there is bright moon-light; on other nights whenever the weather is unsettled.

All Lamps must be extinguished at sunrise.

APPENDIX F (1).

UPPER CHENAB CANAL.

Rules and Regulations for the management of the War and Headworks, Merala.

Officer in charge. The management and maintenance of the Weir and Headworks are under the immediate charge of the Assistant Engineer, Headworks Sub-Division, whose headquarters are at Merala.

His Duties. 2. The Assistant Engineer should not be absent from Merala at night during the flood season from May to October without the sanction of the Executive Engineer.

This sanction will never be given except when the Executive Engineer is himself at Merala.

His duties are as follows:—

(*a*) To comply promptly and as accurately as possible with all indents.

(*b*) To send an explanation by wire to the Indenting Officer if any indent cannot be complied with.

(*c*) To issue written orders regarding the supply to be maintained.

(*d*) To visit the work at night, see that the sentries are on the alert and record his visit in the Log-Book.

(*e*) To personally supervise the preparations for floods and to see that the Establishment do their duty.

(*f*) To see that all gates, gearing, shutters, &c., are in proper order at all times.

Details of Establishment. 3. In addition to the three Gauge Readers (who have nothing to do but to read and register the gauges and report their condition), the maintenance staff shall consist of 28 men:—

2 Jamadars.

20 Beldars.

6 Boatmen.

No reduction in this strength must be made without the sanction of the Executive Engineer, though the selection and appointment of the Regulating Staff will rest with the Assisant Engineer who will be held responsible that the men are healthy, able-bodied, and good swimmers.

Establishment on Right Flank. 4. One Gauge Reader and two Beldars will live in the quarters provided on the Right Bank.

The latter will, if necessary, be changed every two months. During the flood season a special staff to 6 Beldars will be maintained whose duty will be to patrol the Up and Downstream Guide Banks and Retired Embankment and, in the event of anything unusual occurring, they should report the matter to the Gauge Reader who will telephone across to the Jamadar and explain matters.

Book. 5. A Log-Book must be maintained in which the Jamadars must record with date and hour all occurrance and all important orders received.

Orders should invariably be given to the Jamadars and not to the Beldars. The entries in this book will be transcribed into English by the Canal Signaller.

6. The Jamadar will be expected— **Responsibility and Duties of the Jamadar.**

(*a*) to report promptly to the Assistant Engineer any damage or deficiency, which he is unable to rectify and will record the same in his Log-Book with a note of the despatch of the report;

(*b*) to receive and carry out Sub-Divisional Officer's orders as to supply in canal and promptly correct the supply when it is not according to orders;

(*c*) to carry out the requisite regulations in accordance with the rules laid down when the Sub-Divisional Officer is not present at the time and in no way to deviate therefrom except in so far as the safety of the works may demand;

(He must not raise the shutters without written orders or lower them except in case of extreme urgency.)

(*d*) to exercise under the Sub-Divisional Officer's orders immediate control over the beldars and boatmen and to drill them in their duties. He will report sick or inefficient men and see that no one is absent without leave granted by the Sub-Divisional Officer, calling the muster roll at odd hours and entering the name of the absentees in his Log-Book;

(*e*) to see that all gates, gearing, shutters, etc., are kept clean and well oiled and that all breakages are reported promptly to the Sub-Divisional Officer;

(*f*) to see that no person loiters about the works or mounts on to the platform of the superstructure of the undersluices or handles any of the machinery. To prevent any person, except canal employees, from crossing over the weir crest;

(*g*) to prevent rafts or boats from passing over the Weir or through the undersluices until the Sub-Divisional Officer's permission is obtained;

(*h*) to arrange the working of the sentry programme and make petty variations in cases of sickness;

To see that all lanterns are ready trimmed before nightfall and that one lantern is always burning at night in the Gauge well.

(*i*) to prevent any person, not officials on duty, from using the wire ropeway and to see that not more than two passengers are caried. No sentry on duty should be called upon to man the ropeway or called off during his watch for any miscellaneous work.

7. The Naib Jamadar will exercise under the Jamadar's orders, control over the Beldars and boatmen and will assume charge of the workh during such hours as the Executive Engineer may, from time to time, order in writing. While on duty he will have the same responsibilities and duties as the Jamadar and in the event of a flood coming down will inform the Jamadar. **Naib Jamadar**

Duties of Beidars, Left Flank.

8. (*a*) To patrol and keep clean the Regulator and Undersluices, Weir and Left Bank Protection Works.

(*b*) To be on watch, in pairs, for 2 hours at a time, under the orders of the Jamadars, one man to watch the Gauge well and the other to patrol the works and read the river gauges above the regulator and below undersluices every half hour.

(*c*) To keep a sharp lookout for all changes in the weather or in the river or canal and report the same to the Jamadar or Naib Jamadar.

(*d*) When on duty to wear their badges and remain at their posts till relieved, and when not on duty to spend their time in cleaning winches, machines, lamps, etc.

Duties of Boatmen.

9. (*a*) To keep the boats clean, fully furnished and ready for use.

(*b*) To be always prepared to man one boat and when not in the boat to help the Beldars in their work

(*c*) To sleep at nights in the Regulating Quarters.

Regulation Rules.

Working of Weir Shutters.

10. In order to keep silt out of the canal, the Regulation should be effected whenever possible by means of the Weir Shutters, Partial Working of a Bay is apt to create scour below the Weir talus and to cause damage to Weir, hence should not be resorted to, without Executive Engineer's orders and, as far as possible, regulation should be done by dropping all the shutters in one Bay.

11. At all times, and unlesss Superintending Engineer has given orders to the contrary, the Weir Shutters will be dropped down beginning from the left flank of the weir while the raising will be done from the right flank. That is to say, when the river is falling, and it is necessary to raise the Weir Shutters in order to maintain the supply in the canal, the Shutters of Bay No. 8 will first be raised then No. 7 and so on to No. 1.

In a rising river the Shutters will be lowered beginning with Bay No. 1, and ending with Bay No. 8, but this order may be modified to scour out islands on sandy deposits near the Weir.

Working of the Undersluices.

12. The Undersluice Gates should not be raised more than is necessary to keep the undersluice pockets and its entrance free from silt.

The Assistant Engineer should occasionally be present at the raising and lowering of the sluice gates to satisfy himself that the machinery works properly.

13. The supply into the canal will, except during the winter, be admitted over the raised cill gates and minor differences in the supply adjusted by means of two of the Upper Gates.

Small temporary rises in the river may be shut out by lowering the upper gates, but not more than two gates should, as a rule, be kept down for any length of time, a permanent rise in the river being met by dropping more Weir Shutters.

14. To pass a high flood over the Weir the Shutters must first be dropped in the order laid down in rule (11)—if time permits otherwise in any order and as quickly as possible. **Passing high floods.**

If the flood water is heavily laden with silt the undersluice gates should be raised clear and the canal closed temporarily for the number of hours the silt laden flood is on.

15. Emergent closures as distinct from annual closure may be ordered at any time under the authority of the Superintending Engineer when this can be obtained or by the officer responsible for the regulation of the canal. **Emergent closures.**

The Suprintending Engineer should be informed by telegram directly whenever the canal is closed or reopened under this rule.

16. The Signaller at Riasi will wire special warnings of every rise of the river gauge at Riasi of over 1.0 foot to the Executive Engineer and Sub-Divisional Officer and when the river gauge is rising continue to do so at intervals of one hour. On receipt of the information of a rising river the Sub-Divisional Officer will issue any instructions he considers necessary in writing to the Jamadar and Subordinates in charge of the Headworks, and on arrival of the flood at Marala will arrange to inform the staff at Khanki (who will have been previously warned by the Signaller at Riasi) of the time of arrival of the flood with the necessary gauges. **Flood warnings.**

17. The following soundings will be taken at the end of every month throughout the year except those of— **Soundings.**

(1) Which must be taken weekly as long as there is any appreciable quantity of silt there.

(2) At about 50 feet intervals in the pocket between the divide wall and the regulator and extending to about 500 above the undersluice. These soundings will, however, be taken far enough away from the undersluices and regulator to obviate any danger to the operators by their boat being drawn into the canal or below the undersluices.

(3) At every 50 feet downstream of the undersluices to a distance of 500 feet (to be reported to Superintending Engineer).

(4) Radially at the nose of the Divide Groyne to a distance of 60 feet from the toe of the slope.

(5) At every 500 feet in the first two miles of the main line (to be sent to the Superintending Engineer, with the monthly Progress Report.)

(6) After every flood rising to or above R. L. 805.0 on the river gauge, along the centre of the loose stone, pitching up and downstream of the weir the soundings being taken at 20 feet intervals and whenever this can be done without risk to the men employed on the work.

(7) At the noses of the right and left Up and Downstream Guide Banks when subjected to any water action.

18. All serious accidents to the Head Works must be reported at once to the Superintending Engineer and Chief Engineer by telegraph and must be followed up, as quickly as possible, by detailed reports. **Report of accidents.**

R. Ls. of the Work.

19. The R. Ls. of all the important part of the work are given below:—

RIVER.

1.	Merala Gauge ... ... R. L. of Zero.	802.26
2.	Lowest observed Discharge of Chenab at Merala was 5,723 cusecs on 2nd January 1908	796.44
3.	Maximum recorded flood at Merala (23rd July 1903)	809.00

WEIR.

1.	Total length of Weir (8 Bays of 500 feet) ...	4,070 ft.
2.	Thickness of Piers	10 ,,
3.	Upstream apron width	70 ,,
4.	Downstream Slope 1 in 15 length	85 ,,
5.	Upstream Slope 1 in 6	33 ,,
6.	Width of level crest	8 ,,
7.	Number of Weir Shutters 162 per Bay 6.0′ high	1,296 No.
8.	R. L. of Weir Crest in all Bays	800.00
9.	Do. Top of pitching Upstream in all Bays ...	792.10
10.	Do. do. Downstream do. ...	793.83
11.	Do. Top of Piers	823.75
12.	Do. Top of right abutment	818.00
13.	Do. Left Guide Bank Upstream... ...	820.00
13-A.	Do. Left Guide Bank Downstream ...	814.00
14.	Do. Right Guide Bank Upstream ...	818.00
15.	Do. do. Downstream ...	814.00
16.	R. L. of Retired Embankment ...	818.00
17.	Do. Bottom of crest wall	788.50
18.	Bottom of wells of line A....	768.50
19.	Do. lines B and C	778.80
20.	Bottom of wells of Groynes	768.50
21.	Width of Upstream pitching	40 ft.
22.	Width of Downstream do....	50 ,,

UNDERSLUICES.

1.	Total width	318 ft.
2.	No. of Spans 8 of 31.0 each	...
3.	Thickness of Piers	10 ft.
4.	Floor Upstream length	75 ,,
5.	Floor Downstream length	142 ,,

6. R. L. Roadway over Undersluices 818.00
7. Do. Top of Divide Groyne 818.00
8. Do. Floor of Undersluices ... 792.10
9. Do. Top of Gate 805.75
10. Do. Well foundation Upstream curtain 782.10
11. Do. Well foundation under crest ... 768.50
12. Do. Under Downstream curtain ... 768.50
13. Do. of Piers, Abutments and wing walls 768.50
14. Pitching Downstream length ... ... 150.0 ft.
15. Top of Piers 818.00

CANAL REGULATOR.

1. Total width ... ... 338 ft.
2. Number of Spans 12 of 24.5 ft. each... ... ...
3. Thickness of Piers ... ... 4.0 ft.
4. Width of Roadway over Regulator ... ... 14 „
5. Pucca Floor, Upstream, Length ... ... 56 „
6. Do. Downstream from end of Upstream floor 59 „
7. R. L. Floor of Regulator and Canal Bed ... 790.15
8. Do. Top of permanent cill ... 795.23
9. Do. Top of movable cill 799.23
10. Do. Roadway over Regulator... ... 816.00
11. Do. Floor Upstream of Regulator ... 792.10
12. Foundation of wells of Upstream curtain ... 782.10
13. Do. do. under cill ... 768.50
14. Do. do. Abutment, River face wall and Piers ... 768.50
15. Foundation of wells under Downstream wing walls, and water wings of Canal 772.50
16. Top of pitching in River Bed 792.50
17. Springing of Arch 804.50
18. Top of Pier Upstream and Parapet 818.00
19. Top of Downstream Parapet 818.50
20. Top of cill gates when down 795.23
21. Bottom of cill 790.73
22. Do. do. up 794.73

23.	Top of Upper Gates	... ...	... 808.23
24.	Bottom of Gates	... ...	... 798.98
25.	Pitching in Canal Bed Downstream, Length		... 100 ft.
26.	Top of Canal water wings	...	... 805.20
27.	Top of Canal Bank	... ...	... 816.00
28.	Cill Gate 4.6″ high	... ...	... ...
29.	Upper Gate 9.3″ high	... ...	... ...

H. W. M. IVES,
Superintending Engineer,
Upper Chenab Canal Circle.

APPENDIX F (2).

PARAS. 8 AND 9 OF THE GENERAL RULES OF REGULATING THE SUPPLY OF UPPER CHENAB CANAL.

8. Any excess or small deficiency at Bambanwala should be distributed rateably between the Main Line Lower, the Raya Branch and Nokhar Branch. An excess of 0.1 foot or over in any branch should be wired from Bambanwala to the Executive Engineer or Sub-Divisional Officer concerned.

9. In case of considerable deficiency in the river supply a programme of rotational turns of branches shall be prepared by Executive Engineer, Merala Division, and brought into force after approval of Superintending Engineer.

APPENDIX G.

LOWER BARI DOAB CANAL.

RULES AND REGULATIONS FOR THE MANAGEMENT OF THE HEADWORKS OF THE CANAL AT BALLOKI.

Officer-in-charge.

1. The management and maintenance of the Headworks and the regulation of the canal are in charge of the Sub-Divisional Officer, Head works Sub-Division, whose head-quarters are at Balloki. During the flood season, *i.e.*, from June 15th to September 30th, this officer shall not be away from his head-quarters for more than six hours at a time, unless the Executive Engineer is himself at Balloki and has formally taken over the regulation.

Establishment.

2. This will ordinarily consist of—

One Subordinate.

One Jamadar.

Two Assistant Jamadars.

Twenty-two Beldars.

Three Gauge Readers.

During the flood season, an additional 14 beldars.

3. These are principally:— *Duties of the officer-in-charge.*

(*a*) To comply promptly and as accurately as possible with all indents.

(*b*) To report by wire to the indenting officer and to the Executive Engineer of the 1st Division, if any indent cannot be met.

(*c*) To appoint suitable men (who must be able to swim) to the Regulating Establishment, to maintain their number at sanctioned scale, to drill them regularly in their duties and to muster them frequently.

(*d*) To visit the Headworks at night in order to see that the night establishment is properly posted and on the alert.

(*e*) To see that all gates and gearing are always in proper working order.

(*f*) To supervise personally all preparations for, and regulation during, floods.

Duties of the Establishment:— The Subordinate.

4. (*a*) To examine all gates and gearing daily, and to report all defects to the Sub-Divisional Officer.

(*b*) To record every morning and evening in the Log-Book (see Rule 10) in the columns provided, the gate openings on the Weir and the Regulator.

(*c*) To transcribe in English into the Log-Book daily all entries in the Jamadar's diaries (Rule 10).

(*d*) To take soundings (Rule 24) and probings (Rule 25).

(*e*) Generally to carry out the instructions of the Sub-Divisional Officer with regard to the maintenance and efficient working of the Headworks.

Jamadar.

5. (*a*) To exercise under the Sub-Divisional Officer's orders immediate control over the Beldars and boatmen, to drill them under the Sub-Divisional Officer's orders in their duties, to muster them every morning and to report sick and inefficient men, and to see that none of them are absent without leave.

(*b*) To report immediatelly all accidents or unusual occurences to the Sub-Divisional Officer.

(*c*) To regulate the supply in the canal according to the orders of the Sub-Divisional Officer and in accordance with the rules when the latter is not present, and not to deviate therefrom, except in so far as the safety of the work may demand.

(*d*) To be on duty in 8 hour shifts with the Assistant Jamadars and if not on duty when a flood is expected or any unusual event occurs, to immediately assume responsibility on being informed.

(*e*) To see that all machinery is kept clean and properly oiled and to report all defects to the Sub-Divisional Officer promptly.

(*f*) To keep the Headworks clean and tidy, to keep loiterers away from them, and to prohibit all but officials on duty from using the Upper Deck of the Superstructure.

(*g*) To prevent boats or rafts from passing over the weir until the Sub-Divisional Officer's permission has been obtained.

(*h*) To maintain a roster of duties for the posts detailed in Rule 7 (*b*).

(*i*) To see that all lanterns are trimmed and ready by night-fall, and that lanterns are always burning at night in the gauge well and at the two gauges on the Upstream Flanks of the weir.

(*j*) To keep a Diary (Rule 11).

(*k*) To see that all men on duty are in uniform and properly dressed.

Assistant Jamadars.

6 (*a*) To exercise, under the Jamadar's orders, control over the beldars and boatmen.

(*b*) To be on duty in 8 hour shifts, and while on duty to have the same responsibilities as the Jamadar.

(*c*) To inform the Jamadar in the event of a flood or any unusual occurrence.

(*d*) To keep a Diary (Rule 11).

Beldars.

7. (*a*) To patrol and keep tidy and clean the Weir, Regulator, Inlet and the four Guide Banks.

(*b*) To be on duty for 2 hours at a time with 4 hours off and to be posted as follows:—

From June 1st to September 30th.

At the Regulator Gauge Well	1
At the gauge on the Left Upstream Flank of the Weir	1
At the gauge on the Right Upsteam Flank of the Weir	1
At the Inlet	1
On the Upper Deck of the Superstructure	4
On the Right and Left Guide Banks	2

From October 1st to May 31st.

At the Regulator Gauge Well	1
At the gauge on the Left Upstream Flank	1
At the Right Upstream Flank and Inlet	1
On the Upper Deck of the Superstructure	4

(*c*) To read each gauge in the lengths to be patrolled at least once every half hour.

(*d*) To keep a sharp look out for all changes in the weather and in the river, and to report the same to the Jamadar on duty.

(*e*) When on duty to wear their badges and uniforms and to remain at their posts till relieved.

(*f*) When not on duty to clean the gates and gearing and to turn out promptly when required by the Jamadar.

8. (*a*) To keep the boats clean and ready for use. **Boatmen.**

(*b*) To be prepared always to man one boat.

(*c*) To stay at the regulating quarters and to carry out the orders of the Jamadar when not manning the boats.

9. To read and register the gauges every morning, noon and evening, and to report on their conditions when occasion demands. **Gauge Readers.**

10. A Log Book in English, of approved type, shall be maintained at the Headworks in charge of the subordinate:— **Log-Book and Diaries: Log-Book.**

(*i*) In it the Sub-Divisional Officer shall record—

(*a*) all orders connected with the regulation;

(*b*) all orders conected with the abnormal working of the weir gates with brief notes of the exceptional circumstances which necessitated their issue, with the results achieved (see Rule 14-*c*);

(*c*) all events connected with floods (see Rule 22);

(*d*) dates and hours of all night inspections;

(*e*) any accident or other unusual event, with date and hour of occurrence.

(*ii*) Also the subordinate shall record therein—

(*a*) the daily readings, morning and evening of gate openings on the weir and regulator in columns provided;

(*b*) accurate translations of all important entries recorded by the Jamadars in their diaries (see Rule 11);

(*c*) any orders which may be telephoned out by the Sub-Divisional Officer, who should verify and initial each such entry as soon after its issue as possible.

11. Each Jamadar shall maintain a diary in which he shall record the action taken by him on the orders of the Sub-Divisional Officer as recorded in the Log-Book and also all notable facts and events with times of occurrence. Each Jamadar as he is relieved of his duties shall make over his diary to the subordinate who shall record a translation of all important entries in the Log-Book and return the diary to the Jamadar before the latter returns to duty. **Diaries.**

REGULATION.

12. The main considerations which should govern the regulation are—

(*a*) to keep silt out of the canal;

(*b*) to maintain an open and as far as possible even channel along the face of the weir between the inlet and regulator;

(*c*) to prevent scour in close proximity to the work;

(*d*) to avoid encroaching on the river supplies to which the Sidhnai Canal is entitled (see Rule 27).

Working of Canal Regulator.

13. To keep silt out of the canal whenever the water is silt laden and especially during June to October, the rising cill of the regulator should be raised to its full height, *viz.* R. L. 629.91. Regulation of the supply in the canal is usually to be effected by means of weir gates so as to pass just sufficient water over the cill as will maintain indent in the canal. The upper gates of the regulator will be used in exceptional circumstances only, *i.e.*, to regulate or close the canal in a very high river.

When the water is clear the Upstream River levels should be kept as low as possible to reduce the water spread and the losses by absorption.

Working of Weir gates. Bays 1-4.

14. (*a*) While the Lower Bari Doab Canal is in flow the river water level, upstream of the Barrage shall be kept ponded up as follows:—

(1) At R. L. 630.0 so long as river water level downstream of the Barrage is below R. L. 622.4.

(2) At such level as may be necessary to pass the demanded canal supply over a gate sill raised to 629.9 when river water level downstream of Barrage is above R. L. 622.4.

Bay 35.

(*b*) All gates of the Barrage, except Nos. 1 and 2 on the left flank, shall be equally raised at all times so as to pass the surplus river flow under them.

Bays 5 to 34.

(*c*) Gates Nos. 1 and 2 of the Barrage to be lifted 50 per cent. higher than the other gates for purpose of scouring the floor in front of the Canal Head.

Bays 30 to 34

(*d*) The ponded river water level upstream of the Barrage shall not be allowed to vary by more than one foot between the two flanks of the Barrage. This provision is intended to prevent excessive scour along the front of the Barrage.

With a rising river.

(*e*) The canal should be closed whenever the river afflux at the Barrage is less than one foot.

With a falling river.

(*f*) Conversely, bays 1 to 4 and 35 being closed first, gates will be lowered commencing from the centre and working towards the flanks.

(*g*) In order to prevent the weir gates jamming during periods when they are usually kept closed and staunched they should be worked occasionally just sufficiently to ensure efficiency.

Inlet.

15. In order to prevent bed scour upstream of it, the regulation with karries at the inlet must be such that the slope of the water surface is never in excess of that of the bed, *i.e.*, the gauge reading at R. D. zero (known as the common point of the Upper Chenab and Lower Bari Doab Canals), should never be in excess of that immediately upstream of the inlet.

Scouring silt in front of Bays 1 to 4.

16. Soundings shall be taken regularly every week from June to October upstream of bays 1 to 4 of the weir in front of the regulator. When silt has been deposited to a level of 626.4 *i.e.*, 3 feet above canal bed, these bays should be opened to scour away the deposit, the canal

being closed for a period not exceeding 24 hours. These soundings shall be submitted regularly to the Executive Engineer, also see Rule 14 (*a*).

17. (*a*) When the river rises to R. L. 631.50 on the gauge downstream of the weir, the canal shall be closed. Procedure in high floods.

(*b*) When the canal is closed to pass a high flood the Barrage gates shall be raised clear of the water surface and hung at a safe level.

18. The canal may be closed under the orders of the officer responsible for the regulation on all occasions of sudden emergency, such as serious accident to the canal banks or works or complete cessation of demand, and as provided for under rules 16 and 17. At Canal Regulator: emergent canal closure.

The Superintending Engineer should be informed by telegram directly the canal is closed under this rule, and when it is re-opened. All Divisional and Sub-Divisional Officers should also be informed by canal telegram of the closing and re-opening of the canal.

19. On re-opening the canal a supply rising to 2 feet in depth in the first hour should be admitted; this should be increased at the rate of 0.5 of a foot per hour till a depth of 4 feet is reached, after which the rate of increase should not exceed 0.2 of a foot per hour. Rate of supply on opening after closure.

When a reduction has been made at the head of the canal by reasons of heavy rain the supply should not be raised again until revised indents are received from the Lower Divisions.

20. If a local fall of rain occurs which exceeds 1 inch in three hours or 2 inches in 24 hours the gauge in the canal shall be reduced by 0.5 of a foot for six hours and Divisional Officers communicated with in order to ascertain the extent of reduction necessary. On raising after such reduction, the increase shall not exceed 0.1 of a foot per hour. Heavy local rain.

21. (*a*) The Meteorological Department supplies warnings of probable heavy rainfall. Flood warnings.

(*b*) The Sub-Divisional Officer at Madhopur communicates all rapid rises of the river at Makesar by State telegram.

(*c*) The Gauge Reader at the Shahdara Railway Bridge telegraphs every increase of 0.5 foot or more within 6 hours, and

(*d*) The Signaller at Marh on the Upper Chenab Canal telegraphs similar information for the " Deg " Nallah.

On receipt of such warnings the Sub-Divisional Officer will issue necessary instructions in writing, and on arrival of floods at Balloki will inform the Executive Engineers, Multan Canals and Muzaffargarh Canals by telegram.

22. A careful record of all floods shall be made in the Flood Register by the Sub-Divisional Officer showing— Flood reports.

(*a*) time of receipt of flood warnings together with all particulars received;

(*b*) time at which flood arrived;

(*c*) time at which it attained its maximum;

(*d*) the highest gauges recorded with the corresponding discharge either estimated or observed;

(*e*) duration of the flood;

(*f*) action of the flood on the Headworks and the Training Works.

Flood embankments.

23. (*a*) All flood embankments and Training Works must be maintained to full section and in a poper state of repair. The growth of willows and " sarkanda " should be encouraged on the earth slopes and berms.

Action necessary if breached.

(*b*) In the event of a breach in the upper reaches of the Right Flood Embankment, the gates of the syphon at R. D. 7,600 should be immediately closed, and when the water has ponded up to such a level that it can flow into the river upstream of the weir, the Flood Embankment should be cut downstream of Spur No. 3.

(*c*) Similarly if a breach occurs in the Left Flood Embankment, it should be cut downstream of Spur No. 1.

Regulators in embankments to be used during high floods.

(*d*) Three regulators are provided in the Left Flood Embankment and one in the Marginal Bund, the former for providing flood waterings to land cut off by the embankment, the latter to pass of drainage water in addition to providing flood waterings. These when worked need to be very carefully controlled in order to prevent excess supplies reaching the syphon at R. D. 32,800 Lower Bari Doab Canal, which is designed to pass a maximum of 300 cusecs only.

Soundings.

24. The following soundings shall be taken monthly throughout the year except (*a*) which must be taken weekly throughout the flood season and whenever there is an appreciable quantity of silt deposit. Unless otherwise specified all soundings shall be at 20 feet intervals on masonry floors and stone bed pitching and elsewhere at 50 feet intervals.

Weir.

(*a*) Bays 1 to 4 along the centre line of each bay for a distance of 750 feet upstream and 700 feet dowstream of the Weir Gates.

(*b*) Bays 5 to 35 along the centre lines of alternate bays in alternate months for a distance of 450 feet upstream and 700 feet downstream of the Weir Gates.

Inlet.

(*c*) On cross lines 50 feet apart, in the inlet channel, for a distance of 250 feet upstream of the crest; and along the centre lines of Bays 8, 11 and 14 for a distance of 400 feet downstream of the crest.

Regulator and Canal, Lower Bari Doab Canal.

(*d*) On cross lines, in the canal, downstream of the regulator as follows :—

(*i*) For a distance of 500 feet at 50 feet apart.

(*ii*) From 500 feet to 2,500 feet at 250 feet apart.

(*iii*)...From 2,500 feet to 10,000 feet at 500 feet apart.

The soundings along the cross lines will be at intervals of 10 feet.

Training Works.

(*e*) On lines across the stone aprons, as follows :—

(*i*) Right and Left Guide Banks both up and downstream, 250 feet apart.

(*ii*) Groyne Heads of guide banks and of all spurs subjected to river action, 50 feet apart.

(*f*) In addition at all sites where they may be considered necessary.

(*g*) Along aprons to determine whether they have sunk or not.

25. These will be taken once a year as soon after the flood season as possible, over Probings.

(*a*) all masonry floors and bed pitching at Headworks;

(*b*) all stone aprons at the Training Works, where they may have been subjected to severe river action.

26. The Sub-Divisional Officer will communicate with the Executive Engineer, personally, when the latter is at Balloki, and by telegram when absent, on all matters of importance connected with the Headworks and Training Works. Communication with Executive Engineer.

27. Ravi river water may only be passed into the Lower Bari Doab Canal when the Sidhnai indent is satisfied.

28. All serious accidents to the Headworks and Training Works must be reported by telegrams to the Chief and Superintending Engineers, and must be followed up as quickly as possible by detailed reports. Accidents.

29. Purely kharif channels on the canal will be closed on the 15th October whether or no water be available and will be reopened on the 1st April.

APPENDIX H.

Rules for the distribution of the supplies of the Jhelum, Chenab and Ravi rivers between the Upper Jhelum, Lower Jhelum, Upper Chenab, Lower Bari Doab and Lower Chenab Canals.

1. (*a*) The river supplies available for distribution are—

(*i*) *Jhelum River.*—The total of the supplies gauged at Ala on the Lower Jhelum Canal and below Jaggu on the Upper Jhelum Canal.

(*ii*) *Chenab River.*—The total of the supplies gauged at Sambrial on the Upper Chenab Canal and at Chenawan on the Lower Chenab Canal.

(*iii*) *Ravi River*—As gauged in the river above the Balloki Weir.

(*b*) From the above will be deducted—

(*i*) The absorption in the Upper Jhelum Canal between Jaggu and the tail inlet into the Chenab River less 10 per cent. of the supply debited to the Upper Jhelum Canal when the Gujrat Branch or Main Line Distributaries are open.

(*ii*) The volumes passed below the Weir at Balloki in compliance with the indents of the Sidhnai Canals.

(*iii*) The supplies utilized in kharif channels between 1st October and the 15th October when all kharif channels are to be closed.

2. The supplies to be debited to each canal are—

(*i*) *The Upper Jhelum Canal.*—As gauged at the heads of the Gujrat Branch and the Main Line Distributaries *plus* 10 per cent. for their share of the absorption between Jaggu and the tail inlet.

(*ii*) *Lower Jhelum Canal.*—As gauged at Ala.

(*iii*) *Upper Chenab Canal.*—A share of the supply gauged at Sambrial in the ratio of *X* to *Y* where *X* is the total of the supplies gauged at distributary heads *plus* 10 per cent. as their share of the absorption, and *Y* is the supply gauged at R. D. 423,000 feet, Main Line Lower.

(*iv*) *The Lower Bari Doab Canal.*—The supplies gauged in the Canal at its Head or 128 per cent. of the aggregate full capacities of all of its Distributaries which may be in flow at any time: whichever volume is the greater.

(*v*) *The Lower Chenab Canal.*—As gauged at Chinanwan *plus* escapage at Chinanwan.

3. The shares of the canals are—

(*i*) *Original shares of the Lower Jhelum and Lower Chenab Canals.*—The shares are proportional to the rabi areas. The areas proposed to be irrigated annually by the complete project furnish the data for the original shares in the river ; the areas in excess of this that have since been attained should be provided for with the areas irrigated from the Triple Project.

On the Lower Chenab Canal the rabi area is to be three-fifths of the annual and the normal rabi is now 1,600,000 acres.

On the Lower Jhelum Canal the rabi area is to be two-thirds of the annual and the normal rabi is now 600,000 acres.

Using the figures in statement 1-A of the Administration Report for 1914-15, the following are the areas to be considered in fixing the shares :—

Name of Canal.	Area proposed to be irrigated annually by the complete project.	Corresponding rabi area for use in calculating original shares	Normal rabi.	Rabi area to share with the Triple Project.
	Acres.	Acres.	Acres.	Acres.
Lower Chenab Canal	1,488,351	893,010	1,600,000	706,990
Lower Jhelum Canal	668,921	412,614	600,000	187,386
Total ...	2,157,272	1,305,624	2,200,000	894,376

(*ii*) *Shares of the Triple Canal Project.*—The area figures are as follows:—

Name of Canal.	Ratio of kharif to rabi.	Kharif on perennial channels.	Rabi.	Total.	Kharif on kharif channels only.	First and last waterings.
	Acres.	Acres,	Acres.	Acres.	Acres.	Acres.
Upper Jhelum Canal ...	1 to 1	131,148	131,148	262,296	43,199	21,600
Upper Chenab Canal ...	1 to 1·5	161,405	242,116	403,521	201,128	40218
Lower Bari Doab Canal	1 to 1·5	372,038	518,149	890,187	...	...
Total ...	...	664,591	891,413	1,556,004	244,327	61,818

(*iii*) *Duty for calculating shares.*—For the purpose of calculating shares the rabi canal head duty for all five canals may be taken at 200 acres per cusec.

The shares will be as follows :—

Canal.		Rabi area.	Discharge at 200 acres per cusec.	
		Acres.		
Original shares to be first met ...	Lower Chenab	893,010		(a) 4,465
	Lower Jhelum	412,614		(c) 2,063
	Total ...	130,562		6,528
Shares in the surplus over the above ...	Lower Chenab ...	706,990		(b) 3,535
	Lower Jhelum ...	187,386		(d) 937
	Upper Jhelum ...	131,148	656	4,456
	Upper Chenab ...	242,116	1,210	
	Lower Bari Doab	516,149	2,590	
	Total ...	1,765,789		8,928
	GRAND TOTAL ...	3,091,413		15,456

$$a+b=8{,}000$$

$$c+d=3{,}000$$

(iv) Shares of balance of total available river supplies after deducting the combined original shares of the Lower Chenab and Lower Jhelum Canals will be :—

Lower Chenab Canal	...	$\frac{3535}{8928} \times 100 = 39\cdot60$ per cent.
Lower Jhelum Canal	...	$\frac{937}{8928} \times 100 = 10\cdot50$,, ,,
Upper Jhelum Canal	...	$\frac{656}{8928} \times 100 = 7\cdot34$,, ,,
Upper Chenab Canal	...	$\frac{1210}{8928} \times 100 = 13\cdot55$,, ,,
Lower Bari Doab Canal	...	$\frac{2590}{8928} \times 100 = 29\cdot01$,, ,,

4. Deficiencies in shares should be made good promptly.

5. Shares are quenched, to the extent to which water is available, when indents are complied with ; this governs reductions of indents for closing breaches and for other internal reasons.

6. No canal is to be debited with the supplies taken over and above its shares provided that the indents of all other canals are complied with This governs excess river supplies due to freshets, etc.

7. Shares are to be calculated from the 1st of October.

8. The water account is to be calculated on morning discharges ; the special Sub-Divisional Officer in charge of the water account will post copies of the daily account each day and the 10 days' balance accounts promptly to all Superintending Engineers and Executive Engineers.

APPENDIX I.

Schedule of water rates sanctioned for the Triple Canals in the Punjab.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Lift.	Per.
		LOWER BARI DOAB CANAL.			
		OCCUPIER'S RATE.	Rs. A. P.	Rs. A. P.	
Irrigation Branch notification No. 547-R. I., dated 23rd April 1913.	I	Cane and waternuts. ...	9 0 0	4 8 0	Crop.
	II	Rice	7 8 0	3 12 0	Do.
	III	Orchards, gardens, tobacco, poppy, indigo, drugs, vegetables, melons, and wheat.	5 0 0	2 8 0	Orchards and gardens per half year; rest per crop.
	IV	Cotton, fibres, dyes (other than indigo), oilseeds and all rabi crops, except wheat, gram, masur, senji, maina and turnips.	4 0 0	2 0 0	Crop.
Irrigation Branch notification No. 101-R. I., dated 16th January 1920.	V	Chari and all kharif crops not otherwise specified.	3 0 0	1 8 0	Do.
	VI	(*a*) Gram, masur, senji, turnips and maina. (*b*) Crops grown on the "*wa h*" of a previous crop. (*c*) Single watering before ploughing for rabi followed by a rabi crop to be applicable only to channels selected by the Local Government.	2 4 0	1 2 0	(*a*) Crop; (*b*) and (*c*) acre.

APPENDIX I—*continued.*

Schedule of water rates sanctioned for the Triple Canals in the Punjab—continued.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Rate per acre. Lift.	Per.
		LOWER BARI DOAB CANAL—*concluded.*	Rs. A. P.	Rs. A. P.	
	VII	Grass, village and District Board plantations—			
		For any number of waterings in kharif season.	1 4 0	0 10 0	Half-year.
		For one watering in rabi season.	1 4 0	0 10 0	Do.
		For two or more waterings in rabi season.	2 8 0	1 4 0	Do.
Irrigation Branch notification No. 0126-R. I., dated 11th July 1919.	VIII	(*a*) Watering for ploughing not followed by any crop in the same or succeeding harvest—			
		(*i*) For any number of waterings between 1st May and 15th July.	0 8 0	0 4 0	Acre.
		(*ii*) For any number of waterings after 15th July.	1 8 0	0 12 0	Do.
		(*b*) Hemp (*san*), and indigo which has been ploughed as green manure before the 15th September.	0 8 0	0 4 0	Do.
Irrigation Branch notification No. 029-R. I., dated 20th June 1919.	Special *	Toria and gram sown together, in the same field.	5 0 0	2 8 0	Crop.
		UPPER CHENAB CANAL.			
		OCCUPIER'S RATE.			
Irrigation Branch notification No. 0223-R.I., dated 8th August 1912.	I	Cane and waternuts ...	9 0 0	4 8 0	Crop.
	II	Rice	7 8 0	3 12 0	Do.
	III	Orchards, gardens, tobacco, poppy, indigo, drugs, vegetables, melons and wheat.	5 0 0	2 8 0	Orchards and gardens per half-year; rest per crop.

*Sanctioned for a period of 3 years from 1919-20.

APPENDIX I—*continued.*

Schedule of water rates sanctioned for the Triple Canals in the Punjab—continued.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Rate per acre. Lift.	Per.
		UPPER CHENAB CANAL—*continued.*	Rs. A. P.	Rs. A. P.	
	IV	Cotton, fibres, dyes (other than indigo), oilseeds and all rabi crops, except wheat, gram, masur, senji, maina and turnips.	4 0 0	2 0 0	Crop.
Irrigation Branch notification No. 97-R. I., dated 16th January 1920.	V	Chari and all kharif crops not otherwise specified.	3 0 0	1 8 0	Do.
	VI	(*a*) Gram, masur, senji, turnips and maina. (*b*) Crops grown on the "*wadh*" of a previous crop.	2 4 0	1 2 0	(*a*) Crop, (*b*) and (*c*) acre.
Irrigation Branch notification No. 0248-R I., dated 20th September 1918.		(*c*) Single watering before ploughing for rabi followed by a rabi crop to be applicable only to following channels selected by the Local Government :— *On Main Line, Upper.* Nokhar Branch. Raya Branch. *On Main Line, Lower* Talwandi. Gujranwala. Kamoki. Metuwala. Joianwala. Khanpur. Sikhanwala. Udyere. Khakh. Maddar. Mangutaru Minor of the Sayadwala Distributary.			

APPENDIX I—*continued.*

Schedule of water rates sanctioned for the Triple Canals in the Punjab—continued.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Lift.	Per.
			Rs. A. P.	Rs. A. P.	
		UPPER CHENAB CANAL—*concluded.*			
	VII	Grass, village and District Board plantations—			
		For any number of waterings in the kharif season.	1 4 0	0 10 0	Half-year.
		For one watering in rabi season.	1 4 0	0 10 0	Do.
		For two or more waterings in rabi season.	2 8 0	1 4 0	Do.
Irrigation Branch notifications Nos. 55-R. I., dated 13th January 1913, and 0118-R.I., dated 11th July 1919.	VIII	(*a*) Watering for ploughing not followed by any crop in the same or succeeding harvest :—			
		(*i*) For any number of waterings between 1st May and 15th July.	0 8 0	0 4 0	Acre.
		(*ii*) For any number of waterings after 15th July.	1 8 0	0 12 0	Do.
Irrigation Branch notification No. 284-R. I., dated 12th March 1920.		(*b*) Hemp (*san*), indigo, and gwara which have been ploughed as green manure before the 15th September.	0 8 0	0 4 0	Do.
Irrigation Branch notification No. 029-R. I., dated 20th June 1919.	Special *	Toria and gram sown together, in the same field.	5 0 0	2 8 0	Crop.
		UPPER JHELUM CANAL.			
		OCCUPIER'S RATE.			
Irrigation Branch notification No. 037-R. I. dated 6th June 1916,	I	Cane and waternuts ...	9 0 0	4 8 0	Crop.
	II	Rice	7 8 0	3 12 0	Do.
	III	Orchards, gardens, tobacco, poppy, indigo, drugs, vegetables, melons and wheat.	5 0 0	2 8 0	Orchards, and gardens per half-year; rest per crop.
	IV	Cotton, fibres, dyes (other than indigo), oil-seeds and all rabi crops except wheat, gram, masur, senji, maina and turnips.	4 0 0	2 0 0	Crop.

*Sanctioned for a period of 3 years from 1919-20.

APPENDIX I—*continued.*

Schedule of water rates sanctioned for the Triple Canals in the Punjab —continued.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Rate per acre. Lift.	Per.
		UPPER JHELUM CANAL—*continued.*	Rs. A. P.	Rs. A. P.	
Irrigation Branch notification No. 105-R. I., dated 16th January 1920.	V	Chari and all kharif crops not otherwise specified.	3 0 0	1 8 0	Crop
	VI	(*a*) Gram, masur, senji, turnips and maina.			(*a*) Crop.
		(*b*) Crops grown on the "*wadh*" of a previous crop.			(*b*) Acre.
		(*c*) Single waterings before ploughing for rabi followed by a rabi crop to be applicable only to the following channels :—			(*c*) Do.
		Main line, Upper Jhelum Canal: 11-R. of Machiana Kharif Distributary. 12-R. or Samanpindi Kharif Distributary. 13-R. or Saroki Kharif Distributary. 14-R. or Phalia Kharif Distributary.	2 4 0	1 2 0	
		Gujrat Branch, Upper Jhelum Canal: 2-L. or Phalia Doshaka Kharif Distributary.			
		These channels will be open only between the 1st April and 15th October, both dates inclusive.			
	VII	Grass, village and District Board plantations—			
		For any number of waterings in the kharif season.	1 4 0	0 10 0	Half-year.

APPENDIX I—*concluded.*

Schedule of water rates sanctioned for the Triple Canals in the Punjab—concluded.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Rate per acre. Lift.	Per.
		UPPER JHELUM CANAL—*concluded.*	Rs. A. P.	Rs. A. P.	
		For one watering in rabi season.	1 4 0	0 10 0	Half-year.
		For two or more waterings in rabi season.	2 8 0	1 4 0	Do.
Irrigation Branch notification No. 0122-R. I., dated 11th July 1919.	VIII	(*a*) Watering for ploughing not followed by any crop in the same or succeeding harvest:—			
		(*i*) For any number of waterings between 1st May and 15th July.	0 8 0	0 4 0	Acre.
		(*ii*) For any number of waterings after 15th July.	1 8 0	0 12 0	Do
		(*b*) Hemp (*san*) and indigo which have been ploughed as green manure before the 15th September.	0 8 0	0 4 0	Do.
Irrigation Branch notification No. 029-R. I., dated 20th June 1919.	Special *	Toria and gram sown together, in the same field.	5 0 0	2 8 0	Crop.

*Sanctioned for a period of 3 years from 1919-20.

APPENDIX J.

Numerical strength of Revenue Staff, Superior and Inferior, Triple Canals.

Name of Canal.	Division.	Field Operators.			Office Staff—Munshis.
		Deputy Collectors.	Zilladars.	Patwaris.	
Upper Jhelum ...	Jhelum ...	...	...	...	...
	Phalia ...	1	9	94	19
	Gujrat ...	1	3	32	15
Total ...		2	12	126	34
Upper Chenab ...	Merala ...	...	2	19	5
	Gujranwala ...	1	8	98	18
	Sheikhupura ...	1	5	55	13
	Raya ...	1	5	53	14
Total ...		3	20	225	50
Lower Bari Doab ...	Balloki ...	1	3	40	12
	Okara ...	1	8	69	20
	Montgomery ...	1	7	77	18
	Khanewal ...	1	6	50	17
Total ...		4	24	236	67
GRAND TOTAL ...		9	56	587	151

APPENDIX K.

A.—List of Statistical Statements of irrigation water distribution and working of distributaries.

1. Statement showing discharges, escapages, and water utilised during the year.

2. Abstract of irrigation in acres in each Tahsil for the year.

3. Working Statistics of distributaries for the year.

4. Rainfall Statement at selected stations in inches.

5. Water consumption diagram.

B.—List of statistical returns of Revenue Expenditure and working.

Form 1.—Capital expenditure up to date by main heads of classification

Form 2.—Financial results.

Form 3.—Account of Revenue collections by main heads.

Form 4.—Account of Revenue expenditure by main heads.

Form 5.—Details of direct establishment charges.

Form 6.—Details of Receipts.

Form 7.—Average of Occupier's rates in each harvest

Form 8.—Area irrigated, supply and duty.

Form 9.—Statement giving the principal crops in each harvest and an abstract of classification according to water rate schedule.

176 IB—500—24-11-21—SGPP Lahore.

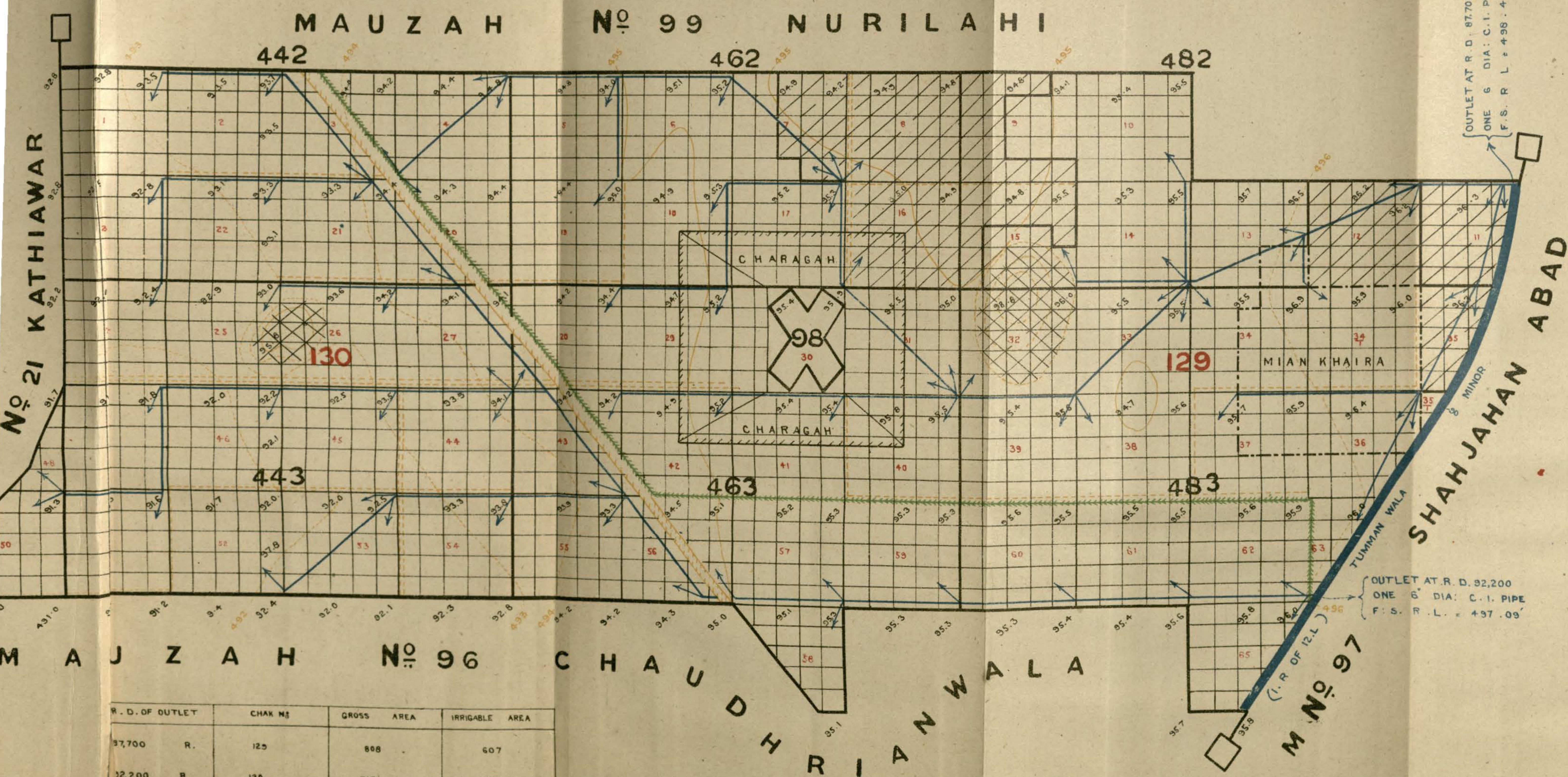

GENERAL
OF
WESTERN
Scale—16 Miles
Area Irrigable by Triple Canal
Area Irrigable by other Connected
Canals
District Boundary
Irrigation Boundary
Railways
Rivers
MUZAFFARGARH
Thal
KARAM C.
SIKANDRABAD C.
MOHAMAD C.
MATTITAL C.
CANALS
SIDHNAI
SIDHNAI
SIDHNAI
INUNDATION
Muzaffarabad
Piran Ghaib
Tatipur
Rashida
Gulzarpur
Khangiwala
Maryala
KHANEWAL RY.
LODHRAN TO
Jahania
Kutabpur
Danyapur
JAMWAH KHURD B.
DIWANWAH
JAMWAH KALAN
BAHAWALWAH
Mailsi


GENERAL IRRIGATION MAP
OF
WESTERN PUNJAB.
Scale—16 Miles = 1 Inch.
Area Irrigable by Triple Canal Project
Area Irrigable by other Connected Canals
Canals
District Boundary
Irrigation Boundary
Railways
Rivers
UPPER JHELUM
LOWER JHELUM CANAL
LOWER CHENAB CANAL
UPPER CHENAB CANAL
LOWER BARI DOAB CANAL
UPPER BARI DOAB
MUZAFFARGARH
F. W. WOODS,
Chief Engineer,
Irrigation Works Punjab.

MAUZAH MIANKHAIRA No. 98

ON (12.L) CHICHAWATNI DISTRIBUTARY

SCALE 6"=1 MILE



R. D. OF OUTLET	CHAK No.	GROSS AREA	IRRIGABLE AREA
87,700 R.	125	808	607
92,200 R	130	717	676

REFERENCES

- MINOR
- WATER COURSES
- VILLAGE SITE & CHARAGAH
- TRIJUNCTION PILLAR & V. BOUNDARY
- BLOCK & RECTANGLE No.
- BAD LAND
- CHAK BOUNDARY
- PROPRIETARY VILLAGE BOUNDARY
- VILLAGE ROAD 66' WIDE
- ROAD TO EACH RECTANGLE
- ROAD VILLAGE TO VILLAGE
- UNCOMMANDED AREA